Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

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Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

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PROBLEMS OF PLANT LIFE.

1. EVOLUTION AMONG LOWLY FORMS (THE ALGAE).

By S. REGINALD PRICE, B.A. (CANTAB.).

EVER since the publication of Darwin's great work, one of the chief aims of the biologist, in studying organic nature, has been the establishment of a scheme indicating the real evolutionary relationships of forms, or, to use the more stereotyped expression, a natural system of classification.

In the plant kingdom certain lines and tendencies within the great groups have been established with a high degree of probability, chiefly from evidence of comparative development, of reproductive structure, and of the fossil record. Of the origin of the great groups themselves, theories and speculations have been numerous; but they are nothing more than bare possibilities, and, perhaps, hardly that in some cases. If, as seems rather probable, all plants evolved from a common stock, the divergence took place countless ages ago, but the voice of the rocks is silent on this question.

Assuming, however, such a common group, it is almost certain that its members were aquatic, and so it seems reasonable to expect that the more primitive members of our existing flora will be found in such an environment. All the evidence goes to show that the Algae as a group—comprising plants almost as simple as may be imagined as well as the quite complex bodies of the higher seaweeds—have never lost their aquatic habit, and so, presumably, the group as a whole has not suffered that great change in the course of evolution which must have accompanied the adoption of the terrestrial mode of life. It has, therefore, been interesting to examine this group carefully, with a view to throwing some light on the evolution of plant-forms within it, and thus indirectly obtaining a dim and indistinct reflection of the process of elaboration of the "Proto-plants."

The evidence has been confined to the study of existing species alone, for the few fossil Algae, often of very doubtful identity, are quite useless as indications of the phylogeny of the group. When, therefore, an evolutionary line is spoken of in this connection, it must be remembered that it represents a series of related species, not necessarily and most often probably not directly related in a single line of descent, but nevertheless giving an indication of the tendency which has led to the elaboration of the various forms. Exactly what is meant may be illustrated by considering several obviously related forms, which may be indicated by the letters A to G, the last being presumed to possess the most complex organisation of the series. Without considering the factors at work, there is reason to suppose that the form A has retained more primitive features and undergone less alteration than B, and so for each succeeding form, the climax of the series being represented by G. The diagram (Figure 208) represents this in a crude manner; the lines running from left to right indicate progressive evolutionary tendencies, while those running vertically indicate

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branches from the stock, which have undergone comparatively little modification, and which terminate in living species. The real direct line is from P, the primitive type, to G, while the so-called evolutionary series is represented by the forms A to G. The conception must usually be understood in this sense, and the *Volvox* line considered below may be cited as a concrete example.

Collective evidence has shown that the main lines of progressive evolution in the Algae have probably diverged from a group represented to-day by the Flagellata, a complex of minute organisms lying on the border line between the animal and vegetable kingdoms. These Flagellates, as their name indicates, are ciliated free-swimming "creatures," often saprophytic in their mode of life, of which some members are colourless, some possess chlorophyll alone as a pigment, while others are coloured yellow, brown or red by substances closely allied to or often, perhaps, identical with those present in the brown and red sea-weeds. There is no need to consider these organisms further here.

Those forms, which are unicellular and motile throughout the greater part of their life-history, seem to illustrate the types of Algae which are nearest to the primitive forms and to their hypothetical progenitors, the Flagellata. Considering for the present the green Algae or Chlorophyceae alone, such forms are found in the order Chlamydomonadaceae (of which the genus *Sphaerella* is a well-known type), and various authors have taken the genus *Chlamydomonas* as a primitive type, and have outlined systems of classification indicating the probable lines of evolution from this.

Chlamydomonas, or the common pool-alga *Sphaerella*, which is very similar, is unicellular, with a single nucleus and chloroplast, and possesses two fine protoplasmic cilia attached to a small beak-like projection at the anterior end of the cell. It is motile by means of these cilia throughout the greater part of its life-history. Reproduction takes place by simple fission of the cell contents, or by conjugation of gametes. Under unfavourable conditions, the cells may go into a non-motile resting condition.

Starting from such *Chlamydomonas* forms, three main series may be recognised among the lowlier Algae leading to the establishment of three distinct types of thallus: one to the formation of colonial bodies, one to the filamentous and plate-like forms, and the third to the so-called siphoneous or coenocytic type of plant body. The organisation of these various types of plant body will be more fully described when we consider the several lines in detail.

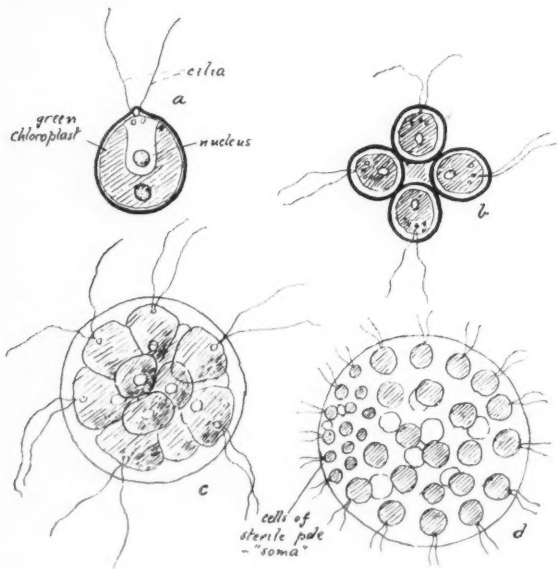

FIGURE 207. Some forms of *Volvox* Line. Diagrammatic.
a. *Chlamydomonas*. b. *Gonium*.
c. *Pandorina*. d. *Pleodorina*.

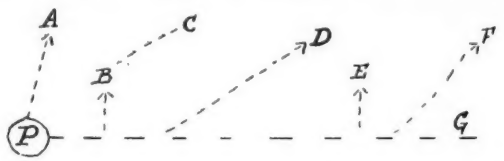

FIGURE 208. Diagram illustrating the evolution of forms.

The Volvocineae comprises a series of genera and species which have long been recognised as closely related, and they seem to illustrate well the stages which have probably led to the development of a free-swimming colony. In *Gonium* there is an association of four or sixteen cells, each like *Chlamydomonas* provided with two cilia, the whole colony being in the form of a flat square (see Figure 207, b). There is a non-motile resting period when asexual reproduction takes place—simply by the division of each cell to form a new colony. *Pandorina* is slightly more complex; there are sixteen cells arranged in the form of a closely packed sphere. The cells are all alike, each with its two cilia, and any cell of the plant can divide to produce a new colony or coenobium as it is called. *Pleodorina* has the cells at one end wholly vegetative and smaller than the rest—the first real indication of the structural unity of state—and the sterile cells represent an incipient vegetative body or "soma" as opposed to the portion concerned in reproduction alone (see Figure 207, d). *Pandorina* is quite common in freshwater pools and ditches in this country, but *Pleodorina* does not seem to occur. The culminating type of the line is *Volvox*, well known to all microscopists. The colonies here consist of several thousand cells arranged in the form of a hollow sphere, and there is a definite sterile pole. There is a fairly high type of sexual reproduction besides the asexual method by division of the parthenogonidia. The unity of the whole colony is still more pronounced than in the

other types, for the cells are in connection with one another by means of fine protoplasmic threads, which connecting threads have not been detected in other colonial forms of this group. These genera may be arranged in a series as shown in the diagram (see Figure 209). The evolutionary

FIGURE 209. Possible scheme of Evolution of *Volvox* Line.

tendency represented by the base line may thus be read as one leading to the association of motile cells to form a free-swimming colony, and to the elaboration and differentiation of the coenobium. It appears that this line has led no further than to *Volvox*, possibly owing to the instability of the large body of loosely connected cells.

The manner of derivation of the filamentous and thalloid types is by no means so clearly indicated by living forms, but still a line can be traced with a fair degree of possibility through the Tetrasporaceae. Essentially, the filament is a segmented tube, each compartment representing a single uni-nucleate cell. Many of the simpler forms, *Ulothrix*, for example, produce zoöspores which are substantially of the *Chlamydomonas* type, indications of the retention of primitiveness in the reproductive condition. Evidently if these filaments and plates have been so evolved, there took place an increase in the length of the resting periods, and an association of the resting cells to form a chain or flat plate. A few examples from the Tetrasporaceae will show that there is certainly some evidence for such a process.

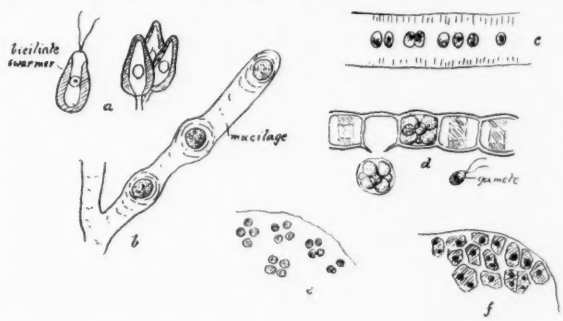

FIGURE 210. Some types of *Ulothrix* and *Ulva* Line.
a. *Chlorangium*. b. *Hormotila*. c. *Radiofilum*.
d. *Ulothrix*. e. *Tetraspora*. f. *Monostroma*.

In *Chlorangium* the swarm-spores attach themselves, develop a short stalk, and divide to form tree-like growths of which any one cell may detach itself and act as a bi-ciliate swarmer. The significance of this genus is rather the marked non-motile stage in the life-history. In *Hormotila* the spherical cells are enclosed in cylinders of mucilage, and the whole association shows some approach to the filamentous condition. Each cell can produce zoöspores by division. *Radiofilum* is still nearer to the filamentous condition (see Figure 210, c). None of these genera is at all common. On the other hand *Tetraspora*, a somewhat common alga, builds gelatinous aggregations of indefinite shape, the spherical cells being arranged in groups of four in the mucilage. *Monostroma* is somewhat similar, but forms a definite plate one cell thick, and on account of its thalloid type of body is generally placed in the Ulvales. These two lead to the genus *Ulva*, a common green seaweed, where the thallus is quite definitely two-layered and more highly differentiated.

A general tentative scheme for the evolution of simple filamentous and plate-like forms is shown diagrammatically in Figure 211.

From the simple *Ulothrix* type a series showing various higher degrees of differentiation may be traced in the plexus of orders called the Ulotrichales, but the consideration of these would lead us into a mass of details rather to be avoided in a purely general outline.

The third main line has probably led to the so-called coenocytic type of thallus, where the plant body is unseptate or nearly so, but each "cell" thus formed is multi-nucleate. The living forms in the Chlorococcineae, none of which is very generally known, however, seem to lie near the root of the siphoneous type. Without going into detail, then, it may be said that *Pediastrum* (a common moorland alga) and *Hydrodictyon* (the beautiful, but rare, "water-net") are really colonies of many multi-nucleate "cells." *Protosiphon* is obviously a fairly primitive member of the Siphonales, possessing a hollow, sac-like coenocytic body. The more highly differentiated members of this group will not be considered, but it may be interesting to note that many of them, like *Caulerpa* or *Acetabularia*, are beautiful forms inhabiting the warmer seas.

It is obvious that our present flora must represent very many lines of descent, which have branched

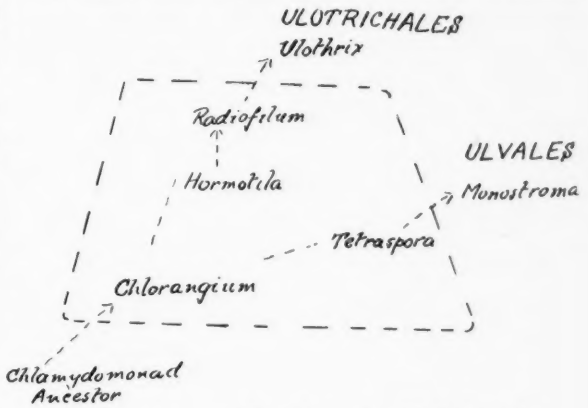

FIGURE 211. Possible scheme for *Ulothrix* and *Ulva* Line.

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into new lines over and over again. The well-worn simile of the tree and its branches will once more serve to illustrate this. The "tree of the Green Algae" has its trunk represented by the main line of evolution from the Flagellata, and then it may be supposed to branch into three—the three lines which have been considered. The Volvocine branch is probably short and with little ramification; the others fork repeatedly, producing finer and finer branches and twigs. The leaves of the tree alone represent existing forms, but here the simile rather breaks down; for it must be supposed that the leaves nearer the top of the tree are more highly evolved than those lower down. The trunk and branches are obscured in the mists of the past, and our problem is to indicate these from a knowledge of the leaves alone. The postulated arrangement of the leaves must give considerable help, but the impossibility of complete solution is patent.

It must be remembered that not one of these proposed modifications in evolution has actually been observed to take place, and the position and basis of the scheme are theoretical. It is quite impossible to dogmatise on any problem of evolution, at least in the present state of our knowledge, and different schools of thought may read quite a different interpretation into the facts.

The forms which have been considered here are all characterised by the bi-ciliate type of zoöspore or gamete, with equal cilia, when any are produced, and this has been thought of sufficient importance to mark off the group, which has been called the Isokontae by Blackman and Tansley. Space does not permit of the discussion of the other groups, but there is evidence that the "coloured seaweeds" have been evolved directly from coloured Flagellates, while the *Oedogonium* forms and the Conjugatae, including the Desmids, and so on, may have sprung from the Isokontan stock.

It is impossible to doubt the great fact of progressive evolution when confronted with this and similar series of organic types. Most of the great underlying principles and laws of the process are still to be elucidated, however. The Algae appear to be still plastic, and further study and observation should at least help us to grasp some of the forces and influences which are at work in the production of a new species in the world flora.

ELECTRICAL CONDUCTIVITY IN THE SERVICE OF BACTERIOLOGY.

By DR. ALFRED GRADENWITZ.

INTERESTING experiments have recently been made by Dr. M. Oker-Blom, Professor at Helsingfors University, on the possibility of utilising the electrical conductivity of bacteria cultures for obtaining useful data on the nature of bacteria and the biological phenomena occurring in these cultures.*

The electrical conductivity of an electrolyte is known to be reduced by the presence of non-conductive substances such as sugar, albumen, and so on, the more so as the amount of these substances is greater. This reduction of conductivity has further been shown to depend on the nature both of the electrolyte and the non-electrolyte, being accounted for by some sort of friction between the ions and non-conductive molecules. If, now, a culture solution containing albumen or sugar, or both of these, be submitted to such conditions that these substances will undergo chemical scission, the conductivity of the system is bound to be influenced in some way or other. On one hand, the conductivity of the culture liquid is increased by reducing through chemical scission the amount of non-conductive substance; if, however, the substances newly formed should likewise be non-electrolytes, the total amount of non-conductive substance in the solution will, as a matter of fact, be increased, and variable effects will be observed according to circumstance. Far more marked effects are, however, obtained whenever new electrolytes are produced in the liquid, and as acids and alkalis are the most highly conductive of these, any variation in the acidity or alkalinity of a culture liquid as produced by bacterial influences is bound to manifest itself in the conductivity of the liquid.

Dr. Oker-Blom has made three parallel series of experiments comparing the respective influences of two bacteria (*Bacterium coli* and *Bacterium typhi*) on the electrical conductivity of culture liquids. The glass vessels used in this connection had been specially constructed on his suggestions, and contained strictly equal amounts of liquid. After their inlet and outlet openings had been stopped with small pads of wadding, they were introduced into a water thermostat, maintaining them at any constant temperature desired, where the electrical conductibility of the liquid could be watched at any moment.

The curves reproduced in the original memoir give an excellent idea of the behaviour shown by the conductivity of culture liquids under the influence of the two bacteria. In the first series the conductivity curve of the *coli* bacteria is found to rise considerably already after two days, and even more rapidly on the third and fourth days, in order afterwards only to rise by degrees somewhat further. The conductivity curve of *typhi* bacteria shows a quite different behaviour. After exhibiting, during the first five days, only a slight tendency to rise, it will rise abruptly on the fifth day, and continue rising in a marked degree from the seventh to the tenth day. After a slight further rise, it eventually approaches towards the *coli* curve, though not reaching it entirely during an eighteen days' experiment. The two curves show between the second and the fifth day the greatest mutual departures.

The liquid used in this connection was Fraenkel's culture liquid, with a slight addition of soda. The two other series of experiments, made with the same liquid, containing one per cent. of lactose and glucose respectively, gave quite similar results. During the first two days a very satisfactory agreement between the curves of conductivity and those of acidity or alkalinity was noted.

These experiments go to show that the bacteriological variations in the electrical conductivity of culture liquids are really determined by products of chemical scission (neutral, alkaline or acid). Though, being only the collective expression of bacterial decomposition, the electrical conductivity thus gives a fairly good idea of the actual phenomena, and as the conductivity curves for each kind of bacteria show some specific features, they might prove useful in detecting these bacteria for the purposes of diagnosis.

* *Centralblatt f. Bakt., etc.*, I., Numbers 4–5, 1912.

WHY ARE WE RIGHT-HANDED?

AN UNBIASED BIOLOGICAL ENQUIRY.

By LEOPOLD KATSCHER.

ALL the more important manual actions are accomplished by the right hand rather than the left. It is the right hand that is used to hold the sword, tool or pen, the right that shakes hands with another, that gesticulates, gives the sign of blessing, takes part in various ceremonies, and so on. The place of honour is conceded to the right hand. In German and French an awkward person is termed "linkisch" and "gauche" respectively. In several other languages "clumsiness" is synonymous with "left-handedness." The English word "sinister" comes from the Latin for "left-handed."

Shortly before his death Thomas Carlyle wrote: "What extraordinary preference is given to the right hand by all mankind! It is probably a matter of the very oldest human organisation. I wonder whether a people exists that makes no difference between the two hands. . . . Why just the right hand should be chosen is an unanswerable question not worth asking, unless it is to be treated as a conundrum. Probably the matter originated in fighting habits, for the left hand shields the heart and surrounding parts better, and is the more suited to carry the shield."

What was considered as inexplicable by the sage of Chelsea later investigators have regarded as well worth research. This is particularly the case with Sir Daniel Wilson, who also offers a plausible explanation in his work on left-handedness, in which theoretical investigation is combined with practical observation, for he was himself left-handed.

It is a fact that many people are left-handed—how does this arise? Is the general use of the right hand alone a rooted, inherited consequence of a primeval habit of mankind? Or is it to be attributed to natural and, therefore, more or less immutable causes of a physical and constitutional nature? To become clear on the subject, investigation must first be made as to the degree in which right-handedness prevailed in the past and does prevail in the present, and whether there was a time when both hands were used indifferently, or whether this has never been the case at all. The celebrated novelist, Charles Reade, who was able to use both hands with the same skill, and justly urged the training of children to practical ambidexterity, declared himself for the first hypothesis (that in former times no difference was made) in his "Coming Man" (1882), and asserted that there are still savage tribes among which no preference is shown for any one hand. If such is the case, the preference would be the result of an artificial habit acquired later. A recent investigator, Dr. Ernst Weber, also expresses his conviction that there was a time when men used both arms indifferently. At that time, those who happened to choose the right arm for fighting had the advantage of shielding their hearts as they pushed forward with the right side foremost. "Thus more left-handed than right-handed men perished before begetting progeny, and the right-handed were, therefore, more often able to transmit their habit of fighting with the right, and so their numbers increased," while the left-handed, who became ever fewer, endeavoured to overcome their pernicious habit till right-handedness became all but general. Dr. Manfred Fränkel believes this theory to be in accord with fact, as it may be concluded from the statues that have come down to us, that in the Stone Age there were many more left-handed people than there are now. He adds: "What happened in the fight may soon have been retained in all other manipulations. Practical deliberation caused them to pursue the course of development once begun, and so right-handedness was transmitted by heredity, and superinduced by habit and training to a definite characteristic of humanity."

This hypothesis is not without deficiencies and, therefore, not altogether satisfactory. Sir Daniel Wilson, who devoted many years of study to the subject, has come to quite a different conclusion founded upon archaeological, palaeontological, philosophical, geological and historical researches. As regards the prehistoric cave-dwellers of the Stone Age, Sir Daniel has most carefully examined their flint implements and has come to the conclusion that they were right-handed with rare exceptions. He makes the same inference from the many references in all the known oldest and most primitive languages, as well as ancient writings. The fact that several oriental languages, including Hebrew, are not written from left to right, but in the opposite direction, might at first sight argue for left-handedness, but a closer examination contradicts the supposition. These writings are not continuous, they are separated, so that it is perfectly natural that they should be written with the right hand. A superficial inspection of some of the old Egyptian monuments leads to an inference of left-handedness, but a thorough study reveals this to be wrong. Although in drawing the profile of a face a right-handed artist would depict the left side as a matter of course, and many Egyptian reliefs present faces turned to the right, the reason is not to be found in

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the possible left-handedness of the sculptors in question, but in deference to architectonic effect. Even when a figure is represented holding a pen or a sword with the left hand, it is only as an exception which is to be traced back to considerations of symmetry and perspective. Where such considerations are not necessary, preference is always given to the right hand. With regard to the monuments of Central America testifying to a long vanished civilisation, it is to be noted that the stone figures mostly face towards the left and will have been chiselled, therefore, by right-handed artists.

Separate designations, in different languages, of the quarters of the heavens also speak for the age and generality of right-handedness. Thus, for instance, the Hebrew word "jamin" signifies both "south" and "right hand." The same is the case with the Sanscrit "dakschina," derivations of which are to be found in most Indo-European languages, and the like is to be met with elsewhere as well. These double meanings originate in the fact that the peoples in question took their bearings from the position of the rising sun, and the south was, of course, on their right. Sir Daniel infers from all this that right-handedness is no chance or mere habit, but is based on our physical and mental constitution. The fact, therefore, that door-hinges and handles, the spirals of a corkscrew, the adjustment of scissors, and hundreds of other objects are all calculated upon right-handedness rests upon valid reasons. This deduction that there must be some physical reason caused Sir D. Wilson to endeavour to discover its nature. There is a great variety of opinion on this point. The celebrated anatomist, Barclay, for instance, a few decades ago, expressed it as his opinion that the flow of blood was less as to quantity and less regular on the left side than on the right; but Professor Buchanan, of Glasgow University, maintained the theory that right-handedness depends upon mechanical laws in connection with the build and position of the intestines; thus the right lung has three lobes and the left only two, and the liver, the heaviest organ of the body, also lies on the right. Dr. Struthers endeavours to strengthen Prof. Buchanan's theory by asserting that the intestines to the right of the median vein weigh twenty-two and three-quarter ounces more than those on the left. But the above-mentioned scholars acknowledge, and acknowledge respectively, that their theory is not able to account for all the phenomena connected therewith. Sir D. Wilson admits that the arrangement of the intestines exercises some influence, but he seeks the chief reason elsewhere—in the relationship between the hands and the brain. As is well known, the two cerebral hemispheres are the centres of the nervous and muscular force in a contrary sense, the left hemisphere governing the right side of the body and the right hemisphere the left side. "Now the left part of the brain *is larger* and *has more convolutions* than the right, and it *also receives a more direct flow of blood*." * In forty brains Broca found the left frontal lobe to be heavier than the right; and Boyd met with the same result in the examination of five hundred brains. It would thus follow that in cases of left-handedness the right side of the brain would, by way of exception, be heavier than the left. Wilson naturally sought an opportunity for a practical test of this conclusion. After several years of expectation, the opportunity was offered by the death of an incorrigibly left-handed soldier in Toronto. In weighing the brain it was then found that the right hemisphere really was heavier than the left.

A rather queer theory has been advanced by Dr. F. Rosenberger. He connects the predominance of the right hand with the apparent movements of the stars, the need of taking orientation bearings in space, and the consequent necessity for an artificial division of the body into two asymmetrical halves, the left one negative and the right positive, as well as with the fact that an inhabitant of the higher latitudes of the Northern Hemisphere, standing with his face to the sun to take his bearings, can follow the sun's course across the sky better with the outstretched right arm than with the left. Leaving other improbabilities out of the question, Dr. Rosenberger's hypothesis must be wrong from the mere fact that the right-handedness of the inhabitants of the Northern Hemisphere would then necessitate the prevalence of left-handedness among the dwellers in the Southern, which, however, is not in the least the case.

An attempt at an explanation made anonymously in the Paris *Nature* is no happier. It maintains that mothers more often present the better-developed right breast to their infants, whose right arm is thus less cramped and more able to make frequent spontaneous movements, so that it strengthens sooner than the left. Text-books on anatomy make no mention of it, and personal information gathered from experts partly denied it and partly maintained the reverse. Nor can the hypothesis be proved that children are more often carried on the right arm than on the left.

Other investigators assign the reason for right-handedness to the asymmetrical position of the heart and point out that owing to the construction of the aorta the right side of the body has a stronger supply of blood than the left, and that the right arm thus has a distinct advantage through the better nourishment of the muscles. The very structure of the heart would, therefore, enforce right-handedness. This, however, is not valid. Apart from the fact that it has been proved practically that it is not difficult fully to develop the left hand, there exist animals, such as the gorilla, chimpanzee, and seal, with a like anatomical structure revealing no trace of a preference for one side or the other. "In fact, it would be absolutely impossible for birds to fly," remarks Dr. Stekel, rightly, "if they were constructed so as to be right-winged."

* This is contradicted by many anatomists of our own day.

According to Bolk, right-handedness is connected with "the better nourishment of the left cerebral hemisphere which is the nerve centre for the right half of the body." According to Biervliet, "the nervous system also participates in asymmetry." Professor Buschan wrote in 1902:—"In a large majority of cases the right side of adult bodies is the more fully developed, with the exception of the left leg. . . . The activity of the nervous system is always greater on the more fully developed side. If the right ear is the stronger it never happens that the left eye sees best. One is born either right-handed or left-handed, and it is impossible to train a left-handed person to be right-handed, or the other way about."

Other investigators deny that it is "inborn" and it is also frequently asserted that left-handedness *can* be overcome. Among the numerous right- and left-handed persons examined by two German doctors, Langstein and Hecht, there was a young soldier who was originally left-handed, and had overcome the habit of chiefly using his left hand, although with difficulty, when learning his trade, and afterwards during his military service, and for years he had worked easily with his right. Yet, whenever he was in need of special dexterity he made use of the left. It seems possible to get rid of left-handedness, not alone by habit, but also by hypnotic suggestion. Such an experiment was made by a doctor on a left-handed child of four. The child's right hand was held when she was in a hypnotic state, and she was told to make more use of it in the future. The effect of the suggestion was surprising, for the girl began to use her right hand more from that time, and after the third treatment given in the course of a few days, she became right-handed, and has remained so. The report in the *Wiener Klinische Wochenschrift* reads:—"Quite apart from its therapeutic success this case is of peculiar interest because the effect of suggestion upon left-handedness seems to establish that even when left-handedness is developed in childhood, already the two cerebral hemispheres may have originally had equal capacities. The case not only argues against the theory that the superiority of the right half of the brain is the cause of left-handedness, but maintains that it must certainly be possible to prevent left-handedness through early training."

The following extracts, published anonymously in the *Frankfurter Zeitung*, are worth noticing. They recall the conjectures of Carlyle and Weber mentioned above. "The preponderance of the right hand is not a primeval gift, but an achievement of civilisation, an outcome of the progressive corporeal and mental differentiation and division of work. When man became man, when the build of his body enabled and compelled him to walk upright, the right and left hands must have been of equal importance to him. While the legs and feet, as organs of locomotion, still preserve equal rights and duties, the activity of the arms and hands, which was destined to a fuller development, was distributed in such a way that the left hand plays a passive, holding and shielding part, and the right hand an active, seizing and attacking one. The preponderance of the right hand must have been a secondary phenomenon in the first instance. Combat was at that time the principal thing — primeval instinct was a surer guide in orientation than the observation of the stars—and the need in combat with man and beast to shield the most vital part of the body, the heart, with the armed or unarmed left necessitated that the club, axe, knife or spear should be held in the right. This habit was carried into peaceful pursuits. Since the day of primeval manhood, even after the original cause had ceased to exist, the preponderance of the right hand was developed and established more and more in civilised nations through heredity and education. This differentiation is even to-day less marked in some primitive races, and there is also to some extent less distinction made between the upper and lower limbs (prehensile foot). Our children are in a similar position, and must, in fact, be educated to the use and conventional higher appreciation of the right hand. Thus the greater skill of the right hand is occasioned by the structure of the human body, the position of the heart, and perhaps the nature of the aorta, together with man's relation to the outer world and the primitive cause for a stronger development of the right arm, to which factors of civilisation have been added."

Dr. Andrew Wilson has set forth an entirely new theory.* With reference to the fact that the centre controlling the movements of the right arm is situated near the centre of speech in the left hemisphere of the brain, he asks: "Is it not probable that the superiority of the right side of our bodies has kept step in growth with the development of language?" He denies right-handedness to be the outcome of continued practice from childhood in the use of the right hand, and considers it the result of evolution from ambidexterity. Dr. Wilson gives no explanation of left-handedness, to which Sir Daniel Wilson has dedicated a whole book.

The explanations given by the late Dr. Fritz Lueddeckens† for left-handedness as well as right-handedness are very detailed. This German doctor's treatment of the subject is anatomical throughout, and is based upon thorough investigation. The keynote to his exposition is his unqualified rejection of the theory that right- or left-handedness can rest upon habit. Among other things, he says that the hypothesis "is absolutely untenable that man should more and more restrict the collaboration of one half of the brain and become accustomed to the consequent use of one hand if it were true that both cerebral hemispheres had originally equal functions." The mere anatomical fact that the centre controlling the muscles for speech is fully developed on one

* "The Light Side of Science." (Chapter on "Right-handedness.")
† "Die Ursachen der Rechts- und Linkshäendigkeit." Leipzig, 1900.

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side only of the brain—in the case of the right-handed on the left side—excludes the accuracy of the theory of habit as an explanation of right-handedness.

Dr. Lueddeckens opposes the widespread belief that left-handedness is a phenomenon restricted to the hand. On the contrary, it affects the physiological character of the whole left side, which presents the same characteristics in the left-handed as does the right side in the right-handed. This thesis, which Lueddeckens endeavours to confirm in detail, is the leading feature of his researches, together with the preponderance of the left hemisphere of the brain over the right as the chief explanation of right-handedness, in which, as we have seen, Bolk and Biervliet also agree. In support of this theory he examines not only the hand but the arm, brain and spine, the ear, speech, walk, sleep, psychic processes, the whole muscular system, and so on, giving particular attention, however, to the eye. His manifold observations have enabled him to recognise left-handedness, as a rule, in the dilation of the left pupil. As science, the statements about the eye are the most important and valuable in his book.

He emphasises that James Mark Baldwin also considered "the prevalence of the left half of the brain" the natural cause of the predominance of right-handedness, and he quotes from this celebrated investigator's book on the mental development of the child interesting experiments that Baldwin made with his own infant daughter. In the first place he would not allow the child always to be carried on one arm. From the fourth to the tenth month he placed her daily at a fixed hour in a comfortable sitting posture and let her reach out after the most varied objects. During this time he found that no preference was shown for either hand, but it must be noted that no exertion was exacted. As soon as the distance was increased from ten or twelve inches to fifteen inches the child at once evinced a marked preference for the right hand. In the first period of the experiment she stretched out her right hand five hundred and seventy-seven times, her left five hundred and seventy-eight times, and both hands at once one thousand and forty-two times, and in the second period, at an increased distance of the object, out of eighty tests she used her right seventy-four times, the left only five times and both hands together but once. At a distance of thirteen to fifteen inches she used her right hand alone for seizing. If the object were shifted to the left all the greater exertion was made by the right hand in the domain of the left, while there was a diminution in the use of the left hand. On the other hand, I must mention Dr. Manfred Fränkel's assertion that Baldwin's experiment, put by himself (Dr. Fränkel) "to a test with several children and many trials, in no way verified itself."

The right-handed only sleep well on the right side as a rule, and if they fall into a heavy sleep on the left side they often have unpleasant dreams, and sometimes nightmare or pollution. The left-handed, again, generally only sleep well on the left side. The reason is that the pressure of blood is higher on the right side of the brain with the latter, and on the left side with the former. Similarly also, according to Lueddeckens, the characteristics of the left side of the left-handed correspond in every detail with the characteristics of the right side of the right-handed. As the result of numerous observations, "I was astounded," he writes, "at the degree of conformity manifested by the two states or conditions, resembling an object and its mirrored reflection." He lays great weight on heredity in cases of left-handedness. He gives dates and tables showing the frequent recurrence of left-handedness in one and the same family in many instances. With regard to left-handedness in school children, he says in part:—"Cases of left-handedness are, as a rule, soon noticed at school, especially in writing. Although the scholars, often with great difficulty, learn to write with the right hand the characters that are adapted to right-handedness, very many of them show the inclination to use the left. Later, when they notice that it is unpleasant to write against the point of the nib, they often begin to write from right to left in so-called mirror writing, in which they often attain remarkable facility with a relatively small amount of practice. . . . When requested to write her name with her left hand, a left-handed, mentally deficient schoolgirl of twelve executed it in mirror writing, and when a church with a tower to the left and a house to the right was drawn for her, she copied it with her left hand, beginning at the right side of the paper and drawing the tower first, and then, working towards the left, the house. She had learnt at school to write and also knit in the customary right-handed manner, but at times she fell back to knitting with the left hand. Such cases of mirror knitting are probably rare in Germany, though another case had been noticed before in the same school. In any case, it proves what technical difficulties will be overcome instinctively, even where there is mental deficiency, by left-handedness in order to assert itself."

According to Wilhelm Fliess also, in "Vom Leben und vom Tod," in no case are the two sides of the body in perfect symmetry, the left side being more developed in one person and the right in another. Other investigators as well are of the same opinion, but there is novelty in Fliess' assertion that "the significance of both sides changes with these deviations, so that manly women and womanly men manifest a fuller development of the left side of their bodies. Left-handed men are always more womanly, and left-handed women more manly, than the right-handed of their sex. . . . When there is deviation in the characteristics of the sexes and the man is more effeminate, his female side, the left, has a fuller development; and when the woman is more masculine her male side, also the left, is more developed." The connection between the accentuation of the "left" side principle and the mixed

realm of male and female is thus shown. The side corresponding with the opposite sex, *i.e.*, the left, is accentuated more strongly. "Accentuated" does not imply by any means that the person in question is always undoubtedly left-handed. This is as problematic as it is interesting.

Broca's sensational discovery that the centre of speech in the human brain is situated on the left side, which was confirmed and extended by Bastian's painstaking investigations, was all the more a matter for wonder as the examination of animals gifted with a certain power of speech manifested no such one-sidedness. It was established that this one-sidedness in man was connected with his right-handedness. Further research showed that in the case of the left-handed the centre of speech was situated in the right cerebral hemisphere. There was, therefore, no longer any doubt as to the interdependence between the left position of the speech centre and right-handedness. Already in the seventh and eighth centuries scientific men were aware that diseases of the left cerebral hemisphere were very often attended by difficulties in speech, whereas this was extremely rare—only with the left-handed—in cases of disease of the right half of the brain. This, too, confirms Broca's discovery. A right-handed person may suffer loss of speech through a blow on the left side of the head, and a left-handed person by a blow on the right side.

Consequently, people whose two hands are equally skilful should have two speech centres. This seems actually to be the case. Dr. Ernst Weber says that it is easy to detect in children unmistakable traces of two speech centres, but that later one of the centres atrophies owing to the preference given to one hand. But though it atrophies, it can be aroused again and rendered useful by systematic development of the other hand. How very far this resuscitation can be made to go is shown in practice by numerous successful experiments in trying to make people ambidextrous by way of training the left side. Of course, these experiences tend to disprove Dr. Lueddeckens' utter disbelief in gradually acquired habit as a possible cause of the prevalence of right-handedness.

With regard to the number of cases of left-handedness, Hasse and Dehner estimate it at one per cent., many others at from two to four and a half per cent., Flechsig at three per cent., and Biervliet at two and a half per cent. The Bible states that in the tribe of Benjamin, which numbered twenty-six thousand seven hundred men, there were seven hundred left-handed; this would be 2·62 per cent. Up to the present no one has been able to draw up far-reaching statistics referring to thousands of cases—and such alone would be really reliable—as no investigator has examined and compared more than a few hundred.

EFFECT OF SCHOOL WORK ON THE LUNGS.

By DR. ALFRED GRADENWITZ.

INTERESTING experiments have recently been made by Dr. M. Oker-Blom, of Helsingfors, on the respiratory movements on both sides of the chest of twenty-five school children in the course of different kinds of work, by means of an apparatus recording any variations in these movements.* When reading aloud was practised for three minutes, the upper parts of the left lung were found to breathe more deeply than those of the right lung, irrespective of whether the pupil was seated or standing, the ratio of the respiratory movements on the right and left sides respectively being $r : l = 100 : 118$. This is, of course, an average figure, there being sometimes exceptions, especially in cases where the left lung is somewhat abnormal.

The total number of respirations $(r + l)$ on both sides together during reading aloud is on an average seventy-eight when the pupil is standing, but decreases to seventy-two if he is sitting.

The most important point brought out by these experiments, however, is the influence exerted by a prolonged sitting posture on the respiration of the upper part of the lungs. During a sedentary occupation of some duration (*e.g.*, knitting) the two sides of the chest are found generally to have the same amplitude of respiration, the breathing movements of the left side being impeded more than those of the right. This is accounted for by the frequent changes in the position of the body which are made involuntarily from time to time to alleviate the fatigue in the back. In fact, even in cases where there is no habitual scoliosis, the vertical column is found alternately to lean to one side or the other, the body straightening itself from time to time, while a few deeper respirations ensure a certain amount of compensation. In any case the unfavourable influence of any prolonged sedentary occupation generally is more marked in its effects on respiration in the upper parts of the left side than in those of the right. The total number of respirations is found to decrease during uninterrupted sedentary work lasting up to about forty minutes, from seventy-two to thirty-nine, *i.e.*, to about half its original value. This is accounted for by the fact that during sedentary work certain groups of muscles are extended without interruption, thus impeding the freedom of respiratory movements.

In order to obviate the harmful action of prolonged sedentary work it is recommended that such work should be from time to time interrupted by a few minutes' respiratory gymnastics. Not only would such practice prove beneficial as regards respiration and pulmonary exercise, but it would, in addition, have a certain prophylactic effect against scoliosis.

**Internat. Archiv f. Schulhygiene.*

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POLISHED CELTS AND THEIR MANUFACTURE.

By T. H. POWELL.

THE polished celt or axe probably represents the highest artistic and manipulative skill of prehistoric and savage peoples; its outline in fine specimens being perfectly symmetrical, its poise and finish perfection, the skill and patience necessary for its flaking and polishing must have been the result of long experience under conditions of life where time was of little value.

Whether used for cutting wood or as a weapon of offence, a polished celt was necessarily subject to great strain; and it was, therefore, of primary importance that a material should be selected which was not only exceedingly hard, but without flaw, otherwise the celt would fly to pieces directly it was used.

If a stone, such as diorite, were chosen, this would be a matter of little difficulty; but in countries where flint was the only material available, great care and knowledge were required in the selection of a suitable block which would prove homogeneous throughout. The first thing, therefore, was the selection of a suitable mass, probably fresh from the quarry, as it was then more easily worked; and this mass, somewhat larger than the implement to be made, was flaked into a rough oblong with broad flat surfaces with thinner sides and ends. The two ends were then flaked longitudinally, the butt only slightly, but at the opposite end the flaking was continued, first on one side and then on the other, till the edges along the plane of flaking met, and a rough, slightly curved outline resulted (see Figure 225). One of the sides was then chipped from end to end at right angles, the flakes struck off being smaller than at the butt and cutting ends, and the four edges were successively dressed in a similar way till two wedge-shaped sides resulted (see Figure 219). The two broad faces were then trimmed all over in such a way that the celt was thicker along the centre than at the edges (see Figure 224). The next process was the production of the cutting edge, and it is at first difficult to understand how this was done, as the edge is often so true and sharp that no amount of face or side grinding could possibly have produced it. But a comparison of examples will show that it was made much as follows. The roughly flaked mass was held upright in the hand, with the narrow side towards the workman, and the curved edge rubbed backwards and forwards on a piece of quartzite or sandstone, with a rotary movement, till perfectly smooth and symmetrical, the outline aimed at being exactly the same as in the finished article. The celt was then held obliquely, and rubbed backwards and forwards until the broad surface on both sides extending for an inch or more from the cutting edge became smooth and the edge was perfectly thin and sharp (see Figure 217). In many cases very little else was done, the butt end being left in a rough state so that the haft would grip it more firmly; but in the finest examples the grinding and polishing were extended over all the surface from one end to the other both on the faces and sides (see Figures 220 and 222). It is a curious fact that although broken cutting ends of celts are comparatively common (see Figure 214) broken butts are rare. The explanation probably is that the sharp cutting end could often be remounted and used again, or if only an inch or two in length it would form a serviceable wedge. In the case of the butt, however, it seems probable that the fragment, being of fine quality and having cost so much time and labour to produce, was regarded by its owner as a treasured possession, and was used up again for a variety of purposes. If the piece were large a smaller celt could easily be made from it; but if not of sufficient size for that purpose it was made into some other tool, and every good collection contains examples of borers, scrapers, knives, and even hammer stones showing old polished surfaces (see Figures 212, 213, 215 and 216).

It must often have happened that the sharp edge became blunted or damaged in use, and resharpening became necessary. This was easily done by striking off small flakes from both sides, then grinding down until the curved edge again became true and sharp, and finally rubbing down till all marks of flaking were obliterated and repolishing was complete (see Figure 223).

The method employed in the case of diorite and similar tough rocks was altogether different; flaking was out of the question, so the stone was struck or pecked into the required shape and the rough surface subsequently rubbed and polished (see Figure 218).

Flint and the many other materials made use of in the manufacture of celts are necessarily of great hardness. It must be evident, therefore, that the grinding process was both slow and laborious, and as in the finest examples all trace of flaking is completely rubbed away, a polished celt may be regarded as evidence, not only of great skill, but also of almost infinite perseverance and patience.

FIGURE 212.

FIGURE 213.

Flint implements, formed from broken or damaged polished celts.

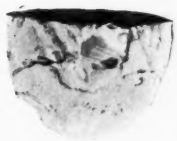


FIGURE 214.

Cutting edge end of a fine flint celt, two and a half inches long, from the Sussex hills, probably broken in use.

FIGURE 215.

FIGURE 216.

Flint implements, formed from broken or damaged polished celts.

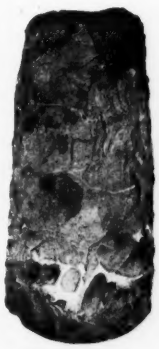


FIGURE 217.

Chert celt, with cutting edge sharpened and nearly finished by rubbing, six and a half inches long (from Denmark).

FIGURE 218.

Celt of hornblende diabase, four and a quarter inches long, from the Oxfordshire hills, of perfect shape and finish.

FIGURE 219.

Side view of flint celt, showing the wedge - shaped form (from Denmark).

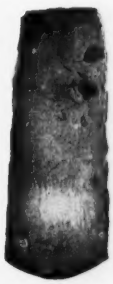


FIGURE 220.

Flint celt from the Beck Collection, said to have been found at Pulborough, Sussex, a beautifully finished Danish implement, five and a half inches long.

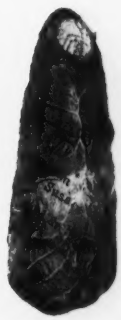


FIGURE 221.

Flint celt found near Horsham, Sussex; the rubbing process begun all over the surface, six inches long.

FIGURE 222.

Flint celt, eight and three quarter inches long, polished on all surfaces (from Denmark).

FIGURE 223.

Flint celt undergoing process of resharpening; the extreme cutting edge is smooth and somewhat thick, thence for about one inch small flakes have been struck off. This only requires rubbing down to produce a perfectly sharp edge. Eight inches long.

FIGURE 224.

Flint celt, eight inches long, flaked into shape and ready for polishing (from Denmark).

FIGURE 225.

Oblong block of chert, nine inches long, with roughly flaked ends, the cutting edge rounded, the one edge trimmed, the other still in the rough (from Denmark).

SUGGESTIONS TOWARDS A SOLUTION OF THE PROBLEM OF THE IBERIAN PLANTS IN SOUTH-WEST IRELAND.

By G. W. BULMAN, M.A., B.Sc.

We do not propose to give here any review of the subject, or to criticise any of the explanations which have been brought forward. On the assumption that a land connection between Spain and Ireland was necessary, and that such really existed, we offer a suggestion as to why these Irish species do not also occur in England. None of the theories we have come across explain this, or even admit it as a difficulty.

Again, assuming that the land connection was pre-Glacial, and that there has been none since the retreat of the ice, we will enquire what grounds there are for believing that much of our present flora may have survived glaciation.

As regards the first point, it is practically impossible to imagine a land connection between Spain and Ireland which did not also include England. And it is to be remembered that Cornwall also has its own peculiar species of Southern plants, which equally need a land connection. The Spanish plants spreading across the assumed land bridge would have had time to reach England also. Why are they, then, not found in this country? One is inclined to suggest at first—and the suggestion has indeed been made—that they were driven out by the cold of the Glacial epoch everywhere but in the south-west of Ireland. To this, however, it may be replied that if they could survive there they could surely do so also in Cornwall and the Scilly Islands. We propose, then, another explanation, founded on the influence of the geological structure of the land on the spread of plants. Let us suppose a set of plants spreading northwards along a line sufficiently extended to reach along our south coast to some distance west of the extreme south-west corner of Ireland. Normally such a migrating band of plants would reach England and Ireland simultaneously. But let us suppose that the advancing front of the Iberian plants meets with a wedge-like barrier of unsuitable ground, mountains, desert, marsh, on merely a different sort of rock. The advance is thereby turned to the north-west and north-east or the two sides of the barrier. The former branch in due course reaches the south-west of Ireland, and the then existing land to the west of this. The other diverges so far that by the time it reaches our latitudes it is too far east to touch our shores. Or the nature of the barrier may have been such as to stop the species altogether from getting further north. The present continental distribution of the species in question, if known in sufficient detail, might possibly indicate which way it was. But the barriers of unsuitable country which prevented the Irish species reaching England may have favoured the spreads of the southern species now found in Cornwall, and the migrating area of the Cornish species may have tapered northwards, and had its apex in Cornwall, which would account for their absence in the eastern part of southern England.

As regards our second point, a careful consideration of the facts seems to suggest the possibility—if not the strong probability—of the survival of many, at least, of our native plants over the Glacial epoch. That the whole of our flora and fauna was driven out or exterminated by the cold is, perhaps, only held by those who have had the "Glacial nightmare" badly. Yet even those who take more moderate views might be excused for doubting the possibility of a fragment of the Spanish flora surviving glaciation in the south-west of Ireland. Let us ask, then, What evidence can be brought forward indicating the possibilities of survival? The present flora of Greenland seems to furnish a strong argument. In spite of its glaciation this country possesses at the present day a considerable number of species of flowering plants. Some of these are members of our own flora. Even, then, if we suppose the glaciation of our land was as severe as that of Greenland to-day, we have here absolute *proof* that some of our species could survive. But it is not probable, in fact, it seems impossible, that the climate of Glacial Britain was as severe as that of Greenland to-day. Even if the amount of ice and snow was as great, or greater, Britain would still have the advantage of its more southern latitude. The amount of heat received during the summer would be as great as—or, according to some authorities, greater than—at present. The amount of land freed from ice and snow during this season would be greater, and the time it remained free longer. Thus, there would be a greater possibility of survival than in Greenland to-day. But this is not all. It is difficult to understand how Greenland can have received its present flora since the Glacial period. The ordinary means of transport, winds, ocean currents, and so on, are not available for Greenland; nor is there any suitable land connection; and Greenland's migratory birds go to it in the spring when there are no ripe seeds for them to carry. It almost seems as if we would have to grant that Greenland's present flora survived

the Glacial epoch there. But if this flora survived, in Glacial Greenland, the necessarily severe conditions, may we not be almost absolutely certain that our flora could survive in milder Glacial England?

And then there arises the interesting botanical question: Does it require a plant to be of a hardier constitution to stand being covered with snow or ice for several months, and then have a warm summer —as it would during glaciation—or to be alternately frozen and thawed—as it is apt to be in our uncertain climate to-day? In other words, would it kill any of our native species to be so treated? A deep covering of snow and ice, in fact, keeps the earth warm. That is why we usually see a stream of water issuing from beneath a glacier. And it is to be remembered that a country covered with ice and snow is not necessarily as cold as Siberia, or the Antarctic. Nor because an ice-sheet or glacier came down to the latitude of London need we suppose that a temperate vegetation could not flourish there. At present alpine glaciers end amid a varied flora, while in New Zealand glaciers come down to the regions of a sub-tropical vegetation. In North America, again, the limits of the forest go up into the ice, and the limits of the ice come down into the forests. Ice and snow require only a temperature of 32° F. for their formation, and unless there are other causes than the presence of these, there need not be intense cold. And it is to be remembered that every pound of water frozen means the setting free of enough heat to raise eighty pounds of water 1° C. Hence the enormous quantities of ice and snow imagined by extreme glacialists do not necessarily imply a proportionately lower temperature. The cold is, so to speak, used up in freezing the water.

The fact that our little group of plants is confined to the south-west corner of Ireland, and that they are Spanish plants, inclines us to view them as tender species. And this makes one of the special difficulties of the case. How could such tender species survive? But may they not in reality be hardier than the facts suggest? The Arbutus stands the winter and ripens its fruit in the southern counties of England, while London Pride is a perfectly hardy plant which does not suffer in our severest winters. Information as to the altitudes attained by the various species in the Pyrenees might help to settle this point. And the fact that some of our species are also natives of Greenland suggests that a group of Spanish plants might be hardy enough to be natives also of a more northern latitude.

But it may be asked, If our plants did survive glaciation, ought there not to be some positive evidence in the form of fossils? The difficulty of obtaining such actual evidence of survival in glacial deposits arises from the fact that many geologists believe that there have been several Glacial periods in Pleistocene times. Thus, if remains of temperate plants are found in such Glacial deposits, the actual beds containing them are classed as inter-Glacial. The plants which had been exterminated by the cold are supposed to have come back during a warm inter-Glacial period. Personally, we have defended the case of one Pleistocene Glacial epoch (*Geological Magazine*, August and September, 1891). And, if this is correct, then there is abundant evidence of the survival of temperate plants during glaciation. But, even on the view of several glaciations, there are not wanting cases where temperate species occur in deposits which are classed as Glacial by reason of the Arctic species which they also contain. Mr. Clement Reid, who advocates the view of several Glacial epochs, and believes that all temperate species were exterminated by the cold, gives detailed lists of species found in various Glacial, and so-called inter-Glacial, deposits. Glancing through these as given in his "Origin of the British Flora," we realise that it must often have been extremely difficult to the author to decide from the plant remains whether the deposit should be classed as Glacial or inter-Glacial. We will take one or two illustrations of this from the above work in support of our contention. Thus, a deposit near Edinburgh is described as follows:—

"In the lower part of the lacustrine deposits filling a silted-up lake are numerous seeds and leaves of Arctic plants. The deposit is probably Late Glacial."

Yet the plant list appended contains such temperate forms as the Creeping Buttercup, the Marsh Violet, the Dandelion, the Bogbean, and so on.

Another deposit, yielding Arctic plants, has in addition to the above temperate forms, Campion, Wood Sorrel, Knot-grass, and so on. Examples of such mingling of Arctic and temperate forms might be multiplied, and even on Mr. Clement Reid's own interpretation of the order of events they seem to indicate the survival of the latter.

Finally, if there is no evidence of a *post*-Glacial land connection, and if we cannot satisfactorily account for the presence of the peculiar flora of south-west Ireland by other means of dispersal, this in itself is a proof of the possibility of survival.

ANNOUNCEMENTS.

EUGENICS as a practical science is now recognised by sociologists as an important factor in race culture; and the Eugenic Club Committee cordially invite the co-operation of ladies and gentlemen who are interested in Eugenics and kindred subjects to communicate with the Secretary, 6, Hand Court, High Holborn, W.C.

MUSEUM EXTENSION AT HULL.—A further valuable gift has just been made to the Hull Municipal Museums Committee by C. Pickering, Esq., J.P., the donor of the new Museum of Fisheries and Shipping at the Pickering Park. It was recently represented to him that the new museum was already crowded with exhibits, and he has kindly presented a strip of land stretching from the Hessle Road to the Pickering Park, and adjoining the present museum, for the purpose of extension.

XUM

TRYPANOSOMES.

By MALCOLM EVAN MACGREGOR, F.R.M.S.

(Continued from Page 200.)

The Effect of Trypanosomes on Man and Animals.

Both in man and animals the effect that pathogenic trypanosomes have while living in the blood is very similar. We will first consider a case of sleeping-sickness in man.

Long ago, when Livingstone penetrated into the heart of Africa he noticed that as he got into certain regions of Central Africa the natives spoke of a disease which made people sleepy, and that the invariable result of this sleepiness was death.

Recognising this and the hopelessness of curing people of the disease when once they had contracted it, the natives were wont to banish the poor unfortunate sufferer from his tribe, so that ere long, without anyone to help or look after him, he died of starvation. What brought this disease, or how it was caught, nobody knew; but while in those days it was more or less confined to comparatively small areas, it has now, since Livingstone's day, spread gradually in Central Africa, and by the name of sleeping-sickness has come to be known as one of the most dreaded diseases of mankind. The trypanosome which causes sleeping sickness is not confined, it is thought, to one species. In the Gambia and other parts of tropical Africa the organism is *T. gambiense*. In Nyasaland and Rhodesia it appears to be caused by a trypanosome of slightly different form, to which has been given the name *T. rhodesiense*.*

The picture of a man suffering from sleeping sickness is a very terrible one (see Figure 226). At first, after he has been bitten by an infected fly, there may be little to notice the matter with him, and the parasites may be in the blood for several months without causing any marked effect—in fact, so long as they remain only in the blood-stream they seem to do little harm.

But after a time they appear in the cerebro-spinal fluid, and then their deadly work begins.

The man's temperature goes up, and he feels generally tired, and exhausted by the slightest effort. He becomes hyperaesthetic, so the little everyday knocks that he receives from surrounding objects while he goes about his everyday duties, and to which, while he is well he pays no attention, cause him the intensest pain. There may now be tingling, or even pain, in the soles of the feet and palms of the hands, and peculiar reddish patches may occur on the skin. This continues for a varying period in different cases, but finally it gives place to just the reverse condition where the patient loses feeling, and gradually becomes stupid, sinking into a heavy lethargy, from which it becomes impossible to raise him. At first this condition is manifest, when one speaks to the sufferer, by his apparent lack of interest in the subject of conversation; he is constantly failing to follow the drift of things, but by raising the voice he is made to grasp what is being said. This continues, and rapidly becomes worse, until in the end a pistol could be fired a few inches from the person's head without his responding at all. There is a dull, sleepy expression about the face; oedema under the eyes and elsewhere causes the skin to have a puffy look, and the man presents the appearance of a person utterly exhausted from want of sleep. So on it goes, until the patient lies completely comatose, the coma ending in death.

This is, to some extent, the outward picture of the man, but besides these symptoms he presents an extremely emaciated condition, and general anaemia. There are infiltrations of lymph into the body cavities, the spleen is usually enlarged, and there are changes in the grey matter of the brain and spinal cord; but on the whole the visible damage to the body is not great.

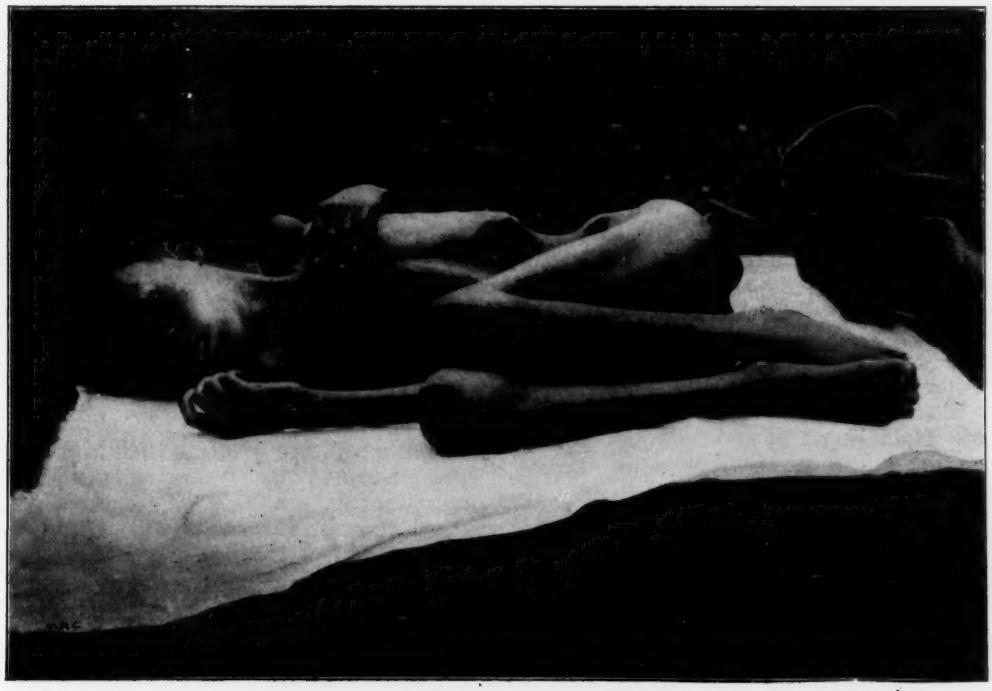
Sleeping-sickness in man is a prolonged disease, and may last as long as three years from the time of its onset to the death of the patient.

In animals, sleeping-sickness produces much the same effect, but its course in the smaller animals, such as the rabbit, the guinea-pig, and the rat, is of much shorter duration, terminating, of course, in the death of the animal.

The actual condition of "sleep" is perhaps not so manifest as it is in man, but it is present nevertheless, and very noticeably in the case of the rat, which places its head between the front paws, rests the crown of the head on the ground, and, throwing the body well forward, looks for all the world as if it were endeavouring to "stand on its head."

It was at first thought by many tribes of natives in Central Africa that sleeping-sickness was caused by the eating of the m'lolo root (manioc), a root that is eaten fairly extensively. Then came the idea that it was produced by eating a certain species of mud-fish, or that it was caused by "integarti" (the native name for devils). Finally, it was recognised that tsetse-flies had something to do with it, and the tsetse-fly was credited with having a "powerful poison," which it injected while it bit, and that it was

* See Footnote on Page 199.



By kind permission *of the Royal Society.*

FIGURE 226. A case of Sleeping-sickness in a Native Child. The last stage in the disease, where, as it will be seen, there is complete coma and extreme emaciation.

By kind permission *of the Royal Society.*

FIGURE 227. A group of Natives and their Children, upon whom the ravages of Sleeping-sickness and starvation are prominently in evidence.

this poison which ultimately killed the animal or person—a theory that at basis was almost right.

But all these theories, and many others, have been exploded completely by the discovery of the trypanosome in the blood of sleeping-sickness patients, and which long since has been proved to be the cause of the disease.

An interesting idea was that the European was less prone to sleeping-sickness than the native, but so far as his susceptibility to the disease is concerned the idea is entirely wrong. There is some truth, however, in the statement that a smaller proportion of Europeans than natives are attacked; but this is probably, in part, due to the fact that most Europeans are not subjected to the same risk, living, more or less, indoors during the day, when the tsetse-fly is at the height of its activities. On the other hand the natives are in the open all day and always subject to the fly's attentions.

There is, nevertheless, a curious thing that has often been noticed, and which undoubtedly has a good deal of bearing on this subject, and that is the tsetse-fly's marked aversion to settling on anything white. It is the prevailing fashion, of course, for the Europeans of tropical parts to dress in white duck, and it has been observed that when a European so dressed and natives have gone to a spot where flies are abundant, the natives are attacked most mercilessly, while the European is comparatively unmolested. That this is due to the colour of his clothes has been proved by tacking a square of black cloth over, say, one arm, when instantly, under the same conditions, the flies will settle on the square. It is probably that the fly instinctively will not settle on white owing to its becoming then conspicuous.

Notwithstanding this, all things being equal, the European quite as readily falls a victim to sleeping-sickness, and he possesses no natural immunity.

Nagana, or the African "fly-sickness" of cattle, is produced, as has been mentioned before, by *T. brucei*, a trypanosome very similar in some of its phases to *T. gambiense*, but which at other times is met with as a small trypanosome of tadpole-like shape, having neither undulating membrane of any width nor "free flagellum." Besides cattle it attacks dogs and cats, while it is pathogenic to most small animals as well. It is harmless, however, to man, and it is found in the blood of wild antelopes and other big game, in which it seems to cause no ill-effects, strangely enough.

Nagana constitutes one of the great cattle plagues of Africa, and has done untold harm to the development of the country for stock-raising; for it is impossible to keep even domestic stock where this disease occurs. Its effects on the animals it attacks are essentially similar to the effects produced by *T. gambiense*, with only minor differences. "Nagana" is a Zulu name, and means "breaking, or withering up," and this name describes the course of the disease very well, since the animals present a most lamentable appearance of utter weakness.

The tsetse-fly responsible for the spread of Nagana is *Glossina morsitans*, a tsetse-fly resembling *G. palpalis* in many ways, but its body is of a lighter brown colour, and has characteristic markings on the abdomen. *Morsitans* is the commonest of the tsetse-flies, and is widely spread over Africa; moreover it is not confined in its haunts to water-tracts.

TREATMENT.

Now we come to the last consideration, namely, the cure of trypanosome diseases. A great deal of work has already been done in this direction, but there is a vast amount more needed yet. There is practically no cure whatever, although there have been rare cases of apparent recovery, which, quite as likely, were due to the patient's own bodily strength as to the success of any "treatment" he may have had.

The drugs known as atoxyl and arsacetin* and other arsenic-containing compounds may be said to be the standard drugs used in the treatment, but an enormous number of substances of all kinds have been tried.

All the drugs like atoxyl are violent poisons, and so have to be used with extreme caution, or the "remedy" becomes worse than the disease, and, in the case of atoxyl, blindness is very easily produced in the patient by the slightest overdose.

Although these drugs do not produce permanent good, they seem to have a beneficial effect sometimes, and if cure meant only the ridding of the patient's blood from trypanosomes, they would indeed be admirable cures. Their effect in this way may be quite remarkable, for while the patient's blood may be swarming with trypanosomes, a dose of atoxyl will completely free it from the parasites in the course of an hour or two. Moreover, it may remain free for months actually, but sooner or later the trypanosomes will reappear, and the course of the disease is not interrupted in reality. What happens to the trypanosomes under the influence of atoxyl nobody knows exactly. It has been said that they "hide" in the bone-marrow or form invisible spore forms, but all the same nobody knows perfectly where they go or what they do in the meantime.

Apart from the drug treatment there is another way of fighting the disease which, while it does not aim at curing people who have already contracted sleeping-sickness, does nevertheless aim at a decided check to the spread of the disease. This consists in removing the natives away from watercourses and areas that the tsetse-fly inhabits, in confining all people suffering from the disease to isolation-camps, in destroying the undergrowth of river and lake

*Atoxyl = $C_6H_4\langle^{NH_2}_{AsO.(OH).ONa}$ Arsacetin = $C_6H_4\langle^{NH.CO.CH_3}_{AsO.(OH).ONa}$

banks near roads and villages—for the tsetse-fly needs the undergrowth as a breeding place—and in the control of natives living in infected areas by preventing their migration to other parts until they have been proved free of the disease.

Since trypanosomes do their work of destruction by some poison—toxin—they secrete, or by using up some essential substance in the blood of their host, which the host needs for the continuance of its life; and since the multiplication of the parasite in the host's blood is unchecked except by the ultimate death of the host, it is safe to conclude that, unlike some bacterial diseases, the body in this case is unable to produce an antitoxin by which to rid itself of the infection. Therefore, I do not think that any "vaccine-treatment" will ever be found of any avail, but the cure must come through the discovery of some drug that shall deal death to the trypanosome and yet not poison the patient. It is not, however, that the trypanosome in itself possesses any extraordinary vitality that makes it difficult to kill but it is merely its position in the host's blood which gives it its present unassailable position; for drugs that are harmful to it are equally harmful to the tissue-cells of the host, and effectually to poison the one means, just as effectually, to poison the other. Trypanosomes in fluid media—blood, and so on—when raised outside the body, only a few degrees above the normal animal temperature, quickly succumb. Were it possible to keep the infected animal at such a body-temperature without killing it, that, perhaps, would be the simplest method of cure! Needless to say this is quite an impossibility, and so, notwithstanding all that has been done up to the present, the difficulty in the cure of trypanosome diseases still awaits solution.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE MOUNT WILSON ONE HUNDRED-INCH REFLECTOR.—Some good news about this great instrument has arrived from California. It was previously reported that the glass disc for the mirror had proved a failure, but it has now been found that the fault was only in the method of mounting, which caused flexure; an improved method gave satisfactory results, and the disc has been accepted and paid for, which indicates confidence that it is sufficiently good. We may hope for some wonderful results in stellar astronomy when this giant instrument is complete. Even the sixty-inch shows stars of the twenty-first magnitude.

THE SPECTRO-HELIOGRAPH.—The Gold Medal of the Royal Astronomical Society was given this year to M. Deslandres for his work on the Sun. The address of the Astronomer Royal gives an interesting summary of his work, calling attention to the spectro-heliograms of the lower, middle and upper layers of the solar atmosphere, which are obtained by shifting the second slit to the outside, intermediate, or central region of the K line. In the upper-layer photographs the prominences can be seen both inside and outside the disc, and it is possible to say whether a limb prominence has its base on the near or remote hemisphere of the Sun and to localise it exactly in the former case. The ordinary limb observations of prominences do not admit of this. Another interesting feature of the high-level spectro-heliograms is the system of long dark filaments, which play the same important part in this layer that spots do in the lowest one. They form a network over the whole disc and sometimes persist for several rotations. They are intimately connected with prominences, one of these being generally present where they cut the limb. M. Deslandres finds that they are centres of rotation about a horizontal axis, the spots rotating about a vertical one. It was also found possible to obtain spectro-heliograms of these in the hydrogen light, using the H_α line, though its narrowness made the difficulty greater than in the K line of calcium. The upper layer of hydrogen shows the same filaments as the calcium ones, while the middle layer shows the vortices round spots, which Hale was the first to detect. Deslandres also devised the "Velocity Recorder," which is a spectro-heliograph with a wide second slit, enabling the whole width of the line to be photographed. As the slit traverses the solar disc, variations in the position and width of the line give indications of the motion of gases in the atmosphere of the Sun. He concludes that on the whole the bright regions are descending and the dark filaments ascending. He thinks that the circulation of a sun-spot is as follows:—The gases in the surrounding regions are ascending, then they approach the facula and go down in it, a continuous circulation being maintained. If the downward motion prevails, the lowest layer may be pierced and a spot formed, while if the upward current prevails a prominence is formed. He also finds in the varying rotational velocity of different parts of prominences (the base having the more rapid rotation) evidence of the existence of a magnetic field in the higher layers, just as Hale had found it in the vortices surrounding spots.

Another interesting solar paper was read at the April meeting of the Society: it was by Mrs. Evershed (Kodaikanal), and was accompanied by a beautiful series of prominence photographs. A certain type of explosive prominence appeared to be intimately connected with spots, and in several of these prominences there was evidence of outward motion, which was, however, slow, this being a different result from that found by Slocum, who noted inward motion. The photographs will be reproduced in the *Monthly Notices*, and it will then be possible to follow the argument more closely.

SPIRAL THEORY OF THE MILKY WAY.—The idea that the Milky Way may be a spiral has been many times put forward. I think Mr. Proctor was the first to do so. Dr. Easton, who is well known for his studies on the subject, gives in *The Astrophysical Journal* for March a small-scale diagram of the whole Milky Way from a combination of photographs and eye drawings, also a spiral form that he suggests might account for the appearance, though he adds that he does not insist on the accuracy of the details. It is of the Catherine-wheel kind, consisting of several curved streams radiating from a large nucleus, which he places in Cygnus. The form was suggested by several spiral nebulae, notably the one in Canes Venatici. At many places the streamers point straight towards us, this being his explanation of brighter portions; since we see a great depth of galactic matter in such streams. He makes one stream pass through the solar system, which seems improbable, as the evidence of the proper motions is that no part of the Galaxy is very near us. The spiral theory is rendered more probable by the fact that a spiral structure is suspected for the Magellanic clouds.

SPECTROSCOPIC DETERMINATION OF THE SUN'S ROTATION.—Many astronomers have investigated the Sun's rotation in this manner in recent years. The obvious advantage is that it can be extended to all latitudes, while the visual method by the spots is confined to the tropical regions. Moreover the spots are clearly of the nature of great disturbances in the photosphere, and there is some objection in using them to give the motion of the undisturbed regions

XUM

The spectroscopic method can be extended to the poles and to undisturbed regions of the surface, and there is the possibility of examining the lines of different elements and seeing whether they indicate the same velocity. The drawback of the method is that the linear velocity of rotation, even at the Equator, is only two kilometres per second; and though this is doubled on comparing opposite limbs it can hardly be determined by the spectroscope within about three per cent., which means an uncertainty of nearly a day in the period. The three most reliable series appear to be those of Adams, Plaskett and DeLury, the last two having been made at Ottawa in 1912, and published in *The Astrophysical Journal* for March.

Table 40 gives the smoothed mean values of the three determinations for each five degrees of solar latitude. They are smoothed by the formula $10°{\cdot}31 + 4°{\cdot}03 \cos^2$ latitude. The values from sun-spots (due to Adams) are given for comparison, also the times of sidereal rotation of different zones.

TABLE 40.

Latitude.	Spectroscope.		Sun-spots.		
	Daily Angular Rotation.	Period of Sidereal Rotation.	Daily Angular Rotation.	Period of Sidereal Rotation.	Carrington's Value.
°	°	d	°	d	d
0	14·34	25·11	14·40	25·00	24·92
5	14·31	25·16	14·38	25·03	25·00
10	14·22	25·32	14·31	25·16	25·19
15	14·07	25·59	14·20	25·35	25·47
20	13·87	25·95	14·06	25·60	25·73
25	13·63	26·41	13·89	25·92	
30	13·34	26·98	13·69	26·30	26·47
35	13·02	27·65	13·47	26·72	
40	12·68	28·39			
45	12·32	29·22			28·46 South
50	11·98	30·05			27·45 North
55	11·64	30·92			
60	11·32	31·81			
65	11·03	32·64			
70	10·79	33·37			
75	10·58	34·03			
80	10·43	34·51			
85	10·34	34·82			
90	10·31	34·91			

There seems to be no clear evidence of different rates from the lines of different elements, such differences as are found being comparable with the probable errors.

Carrington's adopted period for the sidereal rotation is 25·38 days, which corresponds with latitude 14° 6′. His values for 45° and 50° are from too few spots to be reliable.

ULTRA-NEPTUNIAN PLANETS.—I have read with interest Mr. Ling's paper on this subject in the May number, page 171. There are two little points on which I desire to comment. First, at the end of his paragraph (2) he implies that a planet of mass five times the Earth's, at a distance fifty-two, would not sensibly perturb Uranus. But, as Dr. Cowell pointed out, the perturbations which one planet produces on another depend only on the mass of the first and the ratio of the distances of the two planets from the Sun; consequently a planet of mass five times ours would produce the same perturbations (in heliocentric longitude) on Uranus that our Earth would on Mercury if our mass were increased fivefold; but even the present perturbations of the Earth on Mercury are sensible, so that those of the fivefold Earth would be readily so; in the case of planet O and Uranus the slower motion and the longer time for perturbations to accumulate make up for the increased distance between the planets. Again, on page 172 he says that an unexplained rotation of the major axis of the orbit of Halley's Comet undoubtedly exists. If he compares the predicted elements of the orbit with the observed ones he will see that they accord within a few seconds. The discordance of two days does not arise from a rotation of the orbit, but from an alteration in the comet's mean anomaly.

OBITUARY.—I have heard with regret of the death of Professor F. W. Ristenpart, Director of the Observatory of Santiago, Chili. When in Berlin he commenced and partially carried out a very useful work, the combining of all star catalogues into one great catalogue, with determination of proper motions. He discovered a great many errata in the catalogues in the course of his work, and these have already been circulated. He went to Santiago about four years ago. Some interesting observations of his have been published, notably the organising of the observers who watched the occultation of a small star by Ganymede, also good series of observations of Encke's and other comets. He has lately made an attempt to induce astronomers to adopt 1925 as the epoch for all star places deduced up to 1950; for this purpose he has published tables for reducing places from each year to 1925.

THE ORBIT OF SCHAUMASSE'S NEW COMET.—Messrs. Kiess and Nicholson have found these elements:—Perihelion passage, 1913, May, 17·91 G.M.T.; Omega, 57°28′; Node, 317°0′; Inclination, 153°34′. Perihelion distance, 1·440. Ephemeris for Greenwich—Midnight, May 27th, R.A. $18^h\ 22^m\ 8^s$, N.Dec. 35°41′; May 31st, R.A. $17^h\ 22^m\ 42^s$, N.Dec. 39°51′; June 4th, R.A. $16^h\ 19^m\ 13^s$, N.Dec. 41°40′; June 8th, R.A. $15^h\ 21^m\ 52^s$, N.Dec. 41°11′; June 12th, R.A. $14^h\ 35^m\ 48^s$, N.Dec. 39°17′; June 16th, R.A. $14^h\ 1^m\ 24^s$, N.Dec. 36°47′; June 20th, R.A. $13^h\ 35^m\ 56^s$, N.Dec. 34°16′. Nearest earth May 31st, when the distance is sixty-two million miles; it will probably then be of the eighth magnitude.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

CLIMATE CHANGE AND WOODLAND SUCCESSION.—In an interesting paper the Rev. E. A. Woodruffe-Peacock (*Journ. of Bot.*, 1912) claims that historical records of the former occurrence of vineyards in Southern England are indicative of a warmer climate. Other evidence is seen in the more open texture of oaks and pines found in the older peat deposits as compared with the closer texture of the stems found in the more recent peat. The peat deposits of East Anglia are regarded as having developed in relation to woodlands on adjoining higher lands, and the tree-remains represent phases of migration of woodland on to the peat. It is suggested in a general way that the tree-remains represent *periods*—oak being the oldest; ash, holly and elm the more recent. On historical, floristic and faunistic grounds the Scots pine may have always been indigenous in parts of Lincolnshire, as also the beech, which comes in a later period with a warmer climate.

A BRITISH FOSSIL *SELAGINELLA*.—Professor Seward (*New Phytologist*, March, 1913) describes a fossil *Selaginella* (*Selaginellites Dawsoni*) found in beautiful preservation in the Fairlight Clay at the base of the Wealden series at Ecclesbourne on the Sussex coast. The fact that the genus *Selaginella* is now represented in the British flora by a single species (*S. spinosa*), somewhat rare and chiefly confined to hill regions, adds interest to this discovery of a Wealden species which differs from *S. spinosa*, but shows a close resemblance to the widely distributed recent species *S. rupestris*—not found in Europe, however. The vegetative parts are not sufficiently well preserved to show with certainty whether the fossil species had one or two forms of foliage leaves, but the two kinds of spores are extremely well preserved and show the most minute markings on the spore coat with great clearness.

FAIRY RING FUNGI.—Miss Bayliss (*Journ. Econ. Biol.*, Vol. VI) has found that the well-known "fairy ring" fungi *Marasmius oreades* and *Clitocybe gigantea* are not saprophytes, but are parasitic on the roots of grasses, which they kill by the secretion of some toxic substance. The same or some other secretion is toxic to the fungi themselves, making them unable to grow in the same soil for three years in succession, and hence producing the well-known development of yearly widening rings. As compared with the infected grass, that which lies just outside as well as that inside the ring is stimulated into better growth by the greater abundance of nitrogenous food which is made available by the action of the mycelium of the fungi in secreting protein-digesting ferments (proteolytic enzymes). The yearly increase in the radius of the rings was measured—in the case of *Marasmius oreades* it was found to be from six to fourteen inches.

CAUSE OF LEAF-FALL.—From experiments made with detached twigs of various deciduous trees placed in water in a saturated atmosphere Varga (*Oesterr. bot. Zeitschr.*, Band 61) has sought to establish a relationship between this familiar phenomenon and the processes of transpiration and photosynthesis influenced by various conditions of light and temperature. He concludes from the results of his experiments that (1) any decided checking of photosynthesis, either from light conditions or from a deficiency of carbon dioxide, brings about leaf-fall; (2) any lowering of transpiration also induces defoliation, but less rapidly than diminished photosynthesis; (3) variation in the intensity and quality of the light has no direct specific action upon leaf-fall; (4) lower temperatures are effective in producing leaf-fall through decreased photosynthesis and transpiration only within limits which allow the activities involved in the development of the absciss layer—below these limits the leaves die, but cling rather persistently to the twigs.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

INSTITUTE OF METALS.—At the annual general meeting of the Institute, on March 11th and 12th, 1913, the Report of the Council was presented by the President. From this it appears that there has been a steady increase in the number of members, which has risen from three hundred and fifty-five in 1908, to six hundred and fourteen in 1912.

Six papers were also read on this occasion by Fellows of the Institute. These included a study of the "Corrosion of Aluminium," by Dr. G. S. Bailey, in which it is shown that the results obtained by acting upon the metal with acids or alkalies afforded no definite indication of its behaviour in the presence of water or solutions of salts. In the paper read by Mr. Siemens upon "Metal Filament Lamps," an account is given of the evolution of the processes of preparing the wire for these lamps, descriptions of many of which have been given in these columns. The general conclusion reached, is that it is doubtful whether it will be possible to construct a much more economical glow-lamp than the tungsten lamp, and that further progress must be sought in the directions of the improvement and cheapening of the electric supply. The remaining papers by Mr. Gulliver, Messrs. H. & J. Primrose, Mr. Hudson, and Mr. A. Philip are more purely technical in character.

NEW GERMAN INK REGULATIONS.—An account is given by Dr. Hinrichsen in the *Chemiker Zeitung* (1913, XXXVII, 265) of the Prussian regulations for the official tests of writing ink, which came into force last year. In these regulations inks are classified into "documentary" and "ordinary writing inks," and the methods for their analysis and examination are outlined. For example, a "documentary" ink must contain at least twenty-seven grammes of anhydrous gallotannic and gallic acids, with at least four grammes of iron, per litre, and the ratio of tannin to iron must lie within the limits of 4·5 : 1 and 6·75 : 1. Ordinary iron-gall writing inks may contain less tannin, but must still have the same ratios of tannin and iron.

Both kinds of ink must show no alteration in the ink-pot for at least fourteen days, must flow readily from the pen, and must give writing which after being exposed for eight days to the air, is deep black, and can be washed with water and with dilute alcohol.

In testing the permanency of the writing, pieces of standard paper are stretched in a frame inclined at an angle of 45°, and a definite quantity of the ink is made to flow over this paper from a pipette, which is placed in a rest on the frame, so that it is always at the same angle. Simultaneously, parallel ink bands are made upon the paper with a standard ink of known composition, prepared in a definite manner.

The paper, with the colour bands of the two inks upon it, is exposed for eight days in diffused daylight, and is then cut horizontally into three strips. One of these is immersed in water, the second in fifty per cent. alcohol, and the third in eighty-five per cent. alcohol. In none of the strips should there be any perceptible bleaching of the ink.

HARDNESS OF RAINWATER.—Rainwater is commonly regarded as one of the purest forms of natural water, but this is not always the case with the rain that falls in large towns and especially in industrial centres. For example, some years ago it was found that the rainwater in Paris was decidedly hard, and the cause of this was traced to the dust from macadamised roads, the salts in which had been taken up by the rain during its passage through the air.

Another remarkable instance of hard rainwater has recently been investigated by Dr. S. Wolff (*J. Soc. Chem. Ind.*, 1913, XXXII, 345). The water used in some large works outside Manchester has frequently given trouble on account of its hardness, though consisting largely of rainwater collected from the roofs of the buildings. All the samples of the rainwater examined prior to their entering the reservoir were found to be decidedly hard and to give an alkaline reaction. In some of them the proportion of dissolved calcium salts was so great that a scum could be formed by blowing into the water.

A specimen of rainwater collected directly from the roof contained one hundred and seventy parts of total solids per one hundred thousand, and had a total hardness of 87·2 and temporary hardness of 15·75.

In the discussion upon this paper it was mentioned by Mr. W. H. Coleman that much of the coal used in the neighbourhood of the works came from the Bradford Colliery, and that this coal was rich in crystallised carbonate, and it was suggested that the smoke from this coal might convey calcium compounds into the air. Apart from this, a considerable quantity of flue dust must be blown up the chimneys into the air, and a considerable quantity of this must settle upon the roofs; whence some of its soluble constituents would be dissolved by the falling rain.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

OLD RED SANDSTONE AT SOUTHALL.—The interesting discovery of Palaeozoic rocks made by E. Proctor in a boring at Southall is described in the current volume of *The Quarterly Journal of the Geological Society*. The platform of old rocks was struck at a depth of one thousand one hundred and thirty feet, and continued to one thousand two hundred and sixty-one feet, the total depth of the boring. After two hundred and sixty-two feet of gault, the boring entered red and green mottled clays and sandstones, with occasional bands of fine conglomerate. On breaking up the cores remains of fossil fish were found in a marked type of rock occurring in thin bands and consisting almost entirely of organic remains associated with rounded and subangular grains of quartz. The fossils, as determined by Dr. Smith Woodward, consist of scales and teeth of *Holoptychius* and plates of *Bothriolepis*, both of which are characteristic of the Upper Devonian or Old Red Sandstone. This discovery creates a probability that other but unfossiliferous Red Rocks found in other borings in the London Basin are of the same age.

XUM

RAISED BEACHES AND PALAEOLITHIC MAN.—In the April *Geological Magazine* Mr. H. Dewey describes the raised beach of North Devon and discusses its relations to other Pleistocene deposits and to Palaeolithic man. The raised beach forms a shelf and notches the cliffs about ten to fifteen feet above sea-level. Between Croyde Sand and Saunton Down the beach lies on a shelf, and is overlaid by a variable thickness of current-bedded sand, the contained shells of which indicate a warm temperate climate. The raised beach deposit consists of pebbles of slate, sandstone, vein-quartz, quartzite, and chalk-flints. Erratic boulders of a red granite lie on the platform. The granite closely resembles a gneissose granite from Ross-shire; and if this identification be correct, ice is the only conceivable transporting agency. The sand is overlaid by a bed of "head," which in turn is covered by a bed of large rounded stones. A bed corresponding with the latter, occurring at Fremington, contains glaciated stones in a brown loamy clay, and indicates an arctic climate during its formation. A similar bed of glaciated stones overlying "head" was discovered by Mr. Barrow in the Scilly Isles. In the Coombe rock of Southern England and France, which is equivalent and contemporaneous to the "head" of Devon and Cornwall, Palaeolithic implements of Mousterian type have been found.

Mr. Dewey comes to the conclusions that the deposits overlying the raised beaches were formed during a period of variable climate—arctic at first, then warm temperate, finally reverting to arctic—and that early Palaeolithic man lived during the inter-arctic period. He is later than the chalky boulder clay and the raised beach, and earlier than the boulder clay of Glamorgan and South Ireland.

QUANTITATIVE STUDY OF ACTIVE VOLCANOES.—The great quantitative geological investigations which we owe to the Geophysical Laboratory of the Carnegie Institute at Washington are now being supplemented by a study of the physics and chemistry of active volcanoes (Year Book No. 11, 1912). The crater of Kilauea in Hawaii is the one selected for this purpose. During the past summer it was found possible to descend into the crater and collect the volatile ingredients directly from the lava. These gases were collected and sealed in glass tubes without having come into contact with the air at all, and sent to Washington for detailed study. A very important observation is, however, available, and that is that the temperature of the lava in the active basin varies from day to day, and that this variation depends on the quantity of gas emitted. The temperature rises with an increase of gas emission, and falls when the volume of gas diminishes.

The composition of the smoke cloud above the volcano, which contains much non-gaseous matter, was also studied, and samples of the liquid lava were taken directly from the molten lake. It is hoped to determine the character of the chemical reäctions within the gases, between the gases and the liquid lava, and between the gases and the air. Arising out of the recent contention of Brün and others that volcanic eruptions are essentially anhydrous (see "KNOWLEDGE," April, 1911, p. 352), it is mentioned that from one of the gases collected directly from the boiling lava no less than half a pint of water was condensed on cooling.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

DEATHS BY LIGHTNING.—Most people imagine that the number of persons killed by lightning each year is very great. This impression is largely due to the lack of reliable information and to the inherent dread of thunderstorms, and is far from being correct. Dr. A. Jex-Blake, in a recent course of lectures delivered before the Royal College of Physicians on "Death by Electric Currents and by Lightning," gave some statistics on the subject from which he showed that during the ten years 1901–1910, the Registrar-General had reported one hundred and twenty-four fatal instances in lightning stroke in England and Wales—one hundred and eight in men and sixteen in women—a yearly average of only 12·4 deaths, or 0·36 per million living. In the twenty-nine years 1852–1880 there were five hundred and forty-six such deaths, the yearly average for that period being 18·8, or 0·88 per annum per million living. The number of these deaths varied widely in different years; three people were killed by lightning in 1863 and forty-six in 1872. The annual death-rate from lightning also varies widely in different parts of England. In the north Midlands from 1852–1880 it was 1·8 annually per million living, in the Metropolitan district only 0·13 (Lawson)—a figure that should be of comfort to anybody who is in London during a thunderstorm. On the Continent much higher yearly death-rates are found. In Hungary the annual death-rate from lightning is said to be sixteen per million living (Milham); in Styria and Carinthia about ten per million; in Prussia 4·4; in France and in Sweden three; in Belgium two, so far as the imperfect statistics available go (McAdie and Henry). In the United States of America the annual death-rate per million is high—about ten—in consequence of the frequency of thunderstorms on the one hand and of the large percentage of the inhabitants engaged in outdoor labour on the other; about seven hundred or eight hundred deaths from lightning were estimated to occur in the United States every year by Henry in 1900 in a population of seventy-six millions.

Many more people are struck by lightning than are killed. For example, Jack records an instance in which a church was struck: three hundred people were in it, one hundred were injured and mostly made unconscious, thirty had to take to their beds, but only six were killed. Weber gives an account of ninety-two people struck in Schleswig-Holstein: ten were killed, twenty paralysed, fifty-five stupefied, and seven only slightly injured. In 1905, a tent with two hundred and fifty people in it was struck, and sixty were left on the ground in various states of insensibility; one was killed outright, another breathed for some minutes before dying, the rest recovered. As many as eleven and eighteen persons have been killed by a single stroke of lightning. Vincent mentions a stroke that threw down one thousand two hundred and killed five hundred and fifty-six out of a flock of one thousand eight hundred sheep. Dechambre believes that children are perhaps less liable to be struck than adults; but statements such as these are really not capable of proof or disproof.

STORMS ON THE ATLANTIC, JANUARY, 1913.—The month of January, 1913, was probably the stormiest month on record on the North Atlantic Ocean. Mr. R. E. Harris has given an account of the storms of this month, together with some synoptic charts over the North Atlantic at Greenwich mean noon, and also barograms from several vessels.

During the first half of the month several unusually severe storms crossed the North Atlantic, the most severe of which can be traced on the synoptic charts from the 8th to the 11th. This storm was only a moderate depression with two centres at noon of the 8th, the lowest barometer at the primary centre over New York being 29·60 inches. At the same time a severe storm was central near latitude 49° N., longitude 25° W., and was causing winds of force eight to twelve (Beaufort scale) over a wide area north of the Azores between the fifteenth and forty-fifth meridians. By noon of the 9th a rapid development in the western storm had occurred, and it was central near latitude 45° N. and longitude 48° W., with lowest barometer 28·72 inches. Winds of force seven to twelve were prevailing west of the fortieth meridian and north of the thirty-fifth parallel. During the night of the 9th and 10th the storm was at its height, and remarkably low barometer readings were recorded, the lowest, 26·96 inches, being registered on the SS. *Manchester Inventor*, at 1 a.m., on the 10th, at 52° N., 25° 30′ W. This is probably the lowest reading ever made on the North Atlantic. By noon the storm was central near 51° 30′ N., 27° W., with lowest barometer 27·76 inches. Winds of hurricane force were experienced by many vessels north of the fortieth parallel, between the forty-fifth and fourteenth meridians. Within this area ten ships reported winds of force twelve, thirteen

force eleven, five force ten, and nine force nine, out of a total of forty-seven. By noon of the 11th the storm was central near 56° N. and 15° W., and winds of force seven to eleven were prevailing over the ocean north of the fortieth parallel and east of the forty-fifth meridian. Severe gales occurred over the British Isles.

LOWEST BAROMETER RECORDS.—In connection with the above remarkably low reading of 26·96 inches it may be of interest to give what is, so far as is known, the next actual lowest barometric pressure which has been observed in any other part of the world, viz., 27·135 inches on September 22nd, 1885, at False Point, on the coast of Orissa, India. In the British Isles the lowest recorded barometric pressures have been:—27·332 inches on January 26th, 1884, at Ochtertyre, Crieff; and 27·380 inches on December 8th, 1886, at Belfast.

VIOLENT UPRUSHES IN CUMULUS CLOUDS.—Everyone who has carefully watched clouds is familiar with the peculiar boiling and tumbling of large cumulus clouds, their formation of new heads, and the other evidences they often give of violent motions and an explosive-like turbulence. The late Dr. W. von Bezold suggested that these movements indicate that there is a source of power within the cloud itself, and he ascribed this power to the latent heat set free by the more or less sudden condensation of a supersaturated vapour, or the sudden freezing of undercooled water-drops.

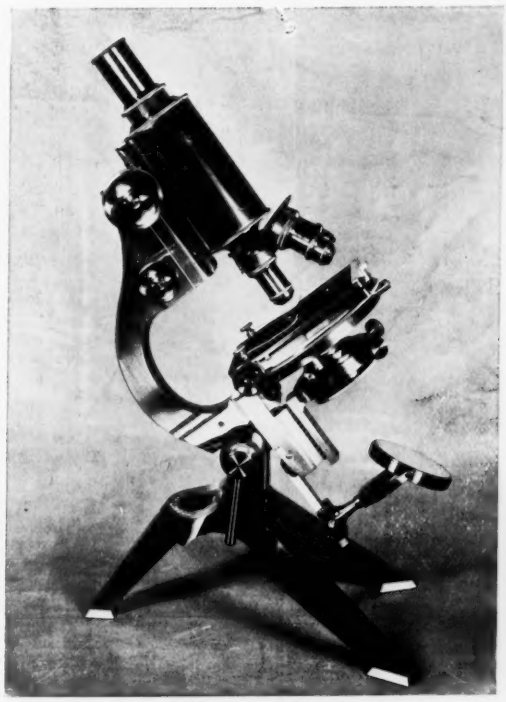


FIGURE 228.
A new model Microscope.

Professor W. J. Humphreys has recently investigated this subject, and he has come to the conclusion that the difference in temperature between the free air and the interior of large cumulus clouds at the same level is the real cause of the violent uprush and turmoil in their centres. He is also of opinion that most of the electrical and other energy of the thunderstorm comes directly or indirectly from the latent heat of condensation set free within the mass of turbulent cumulus clouds.

PHENOLOGICAL OBSERVATIONS, 1912.—At the meeting of the Royal Meteorological Society on April 16th Mr. J. E. Clark and Mr. R. H. Hooker presented their report on the Phenological Observations for the year ending November, 1912. This dealt with the dates of the first flowering of certain plants, the song and migration of birds, the appearance of insects, and the yield of farm and fruit crops. The chief factors affecting the field crops were probably the dry warm April and May, followed by the cold, wet, sunless summer. The spring was perhaps the more important of the two: it affected the corn crops and the hay. All the crops in the United Kingdom were below the average of the preceding ten years, although in Great Britain alone meadow hay was a little better than usual, and hops were also above the mean by fully twenty-three per cent. The harvest of 1912 must be classed as very deficient, and one of the worst experienced for many years.

HARVEST WEATHER FORECAST.—The Meteorological Office will be prepared, from June 1st to September 30th, to supply forecasts of weather by telegraph, to farmers and other persons desirous of receiving them, upon payment of the cost of the telegram. The forecasts are drawn up each week-day, at 2.30 p.m., and refer to the probable weather during the fifteen hours from 6 a.m. to 9 p.m. on the next day. A note as to the further outlook is given when possible. Applications for the forecasts should be sent to the Director, Meteorological Office, South Kensington, London, S.W.

MICROSCOPY.

By F.R.M.S.

A NEW MODEL MICROSCOPE.—Figure 228 represents a new pattern microscope, designed by Mr. E. Leitz, which combines in itself features of both the English and Continental models. There is a tripod base which gives rigidity in the horizontal as well as in the vertical position. A curved limb allows of additional working space on the stage, which is of the square fixed type, though a detachable mechanical arrangement may be added. The sub-stage has centring screws controlling the condenser sleeve which is of the standard gauge of the Royal Microscopical Society, while the fine adjustment is of the type originally introduced into the Leitz Continental Microscopes and consists of a cam and worm screw continuous motion.

FIGURE 229.
A *Rhipicephalus* from Australia.

AN AUSTRALIAN TICK.—A short time ago two small "insects" were sent to me by a friend in Devonshire, who said they had been found on the dress of a child, whose mother, being unable to recognise them, feared they might be some species of *Cimex*, and was anxious to know if this was so, and where it was likely they came from. On placing them under the microscope I saw at once that they were Ticks, but were so flat and so dry that I concluded they had died of starvation, and had been dead a long time. They measured ·18 inch in extreme length and were lemon-coloured, with purple-brown markings and spots. After careful examination and comparison with the figures and descriptions given by Neumann in his "Revision of the Ixodes," I determined them to belong to the genus *Rhipicephalus*, and therefore certainly not British; but as to species they did not exactly agree with anything figured either by Neumann or by any other authority consulted. Having only two specimens I was unwilling to dissect more than one, and having detached and prepared its capitulum I was successful in this instance in getting a clear view of the

chelicerae, though, unfortunately, not also of the hypostome. On looking through the mounted specimens of some fifty species in my cabinet I found that the chelicerae closely resembled those of a Tick sent to me from Brisbane as having been found on a dog in the neighbourhood of the Filbert River in Queensland. How, then, could it have been found in Devonshire? Further enquiries elicited the fact that the child on whose dress these Ticks were found had shortly before been playing on a fur rug made from the skins of Australian Dingoes, and there seemed no doubt that these Arachnids had been imported in this.

R. T. L.

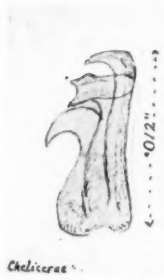


FIGURE 230.
Chelicerae of the *Rhipicephalus*.

A PORTABLE MICROSCOPE.—It is an axiomatic truth that the Continental form of microscope, with its short tube, lends itself to portability better than the English one, with its long tube and extended base.

Messrs. Leitz, in 1899, introduced a portable model, in which a closing V was substituted for the horseshoe foot; but in 1901 further improvements were made by adopting the well-known plan of pivoting the stage, so that it could be turned round into the plane of the optic axis; thus the whole microscope, although of full size, could be folded up into a compact block, which could be packed in a small box (see Figure 232).

Their later microscope model with a horizontal pinion fine-adjustment (introduced in 1903) has now been adapted to this portable form, and one has just been made in which some alterations have been adopted.

First, the stage has been made on my horseshoe plan, and fitted with a sliding bar (Figure 231). It measures 13 × 9 cm.; rather a contrast to the 6 × 4 cm. stage, at one time an extreme size for a Continental microscope!

FIGURE 231.
A Portable Microscope.

Attached below the stage is the usual spiral focusing mechanism carrying a sub-stage ring, which has a small amount of play for centring by means of a spring opposing two screws. A tube sliding into this ring carries an achromatic condenser and an iris diaphragm; below this is a turn-out ring, with a rather deep cell, to hold screens, stops, and so on.

Secondly, the pillar which carries the microscope is fitted with a conical pivot, so that the V-foot may be turned round in order that the toes of the V may face backwards instead of forwards (Figure 231). The rotating foot was first made by John Cuff, 1750. Previously, when the microscope was inclined it was found that its stability was seriously impaired, so much so that when a horizontal position was reached the microscope fell over; but now, when the foot is rotated backwards, the microscope is perfectly stable. Figure 233 shows the instrument holding an Abbe camera in a position for drawing at the side, an increase of stability being required on account of the weight of the large mirror on the top of the tube. In this case the V-foot is rotated half-round. The draw tube has been increased in length, so that with eighteen millimetres for the objective slide or rotating nosepiece, a total of two hundred and eleven millimetres has been obtained. There are some objects which require the whole of that length, even with a short tube objective.

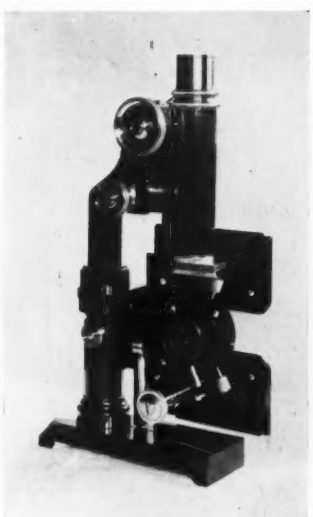


FIGURE 232.
The Microscope folded.

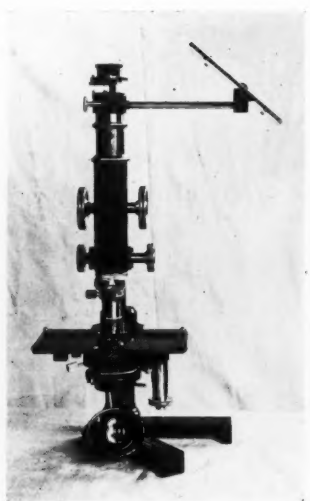


FIGURE 233. The instrument with draw tube increased in length and fitted with an Abbe camera.

In Figure 231 the instrument is seen fitted with one of Messrs. Leitz's eyepieces, with rotating eye-lenses (introduced 1899); the same field lens does duty for both. This is a most convenient and time-saving device. One is a No. 2 (×6), the other a No. 5 (×12). The corrections of these eyepieces are very perfect.

The objectives, six in number, *viz.*, Nos. 1, 2, 3a, apo. 8 mm., 6a and apo. $\frac{1}{12}$ 1·4 N.A., are all supplied with slides, and fit, while attached to their slides, in a separate box: this plan saves much time in screwing and unscrewing and packing them away in their own brass boxes. This box is itself packed in the same case as the microscope, as also are the six brass boxes for the objectives, and an oil bottle.

In addition to the rotating eyepiece, there are Nos. 2 and 3 Huyghenian, a micrometer eyepiece, and an 8, a 12 and an 18 compensating eyepieces. A polariser and analyser has also been added, the whole thus forming a fairly complete microscopical outfit.

EDWARD M. NELSON.

PHOTOGRAPHY.

By EDGAR SENIOR.

IMPERFECT FIXING.—Hypo "Sodium Thiosulphate" is invariably used as the fixing agent for both negatives and prints. Its action depends upon the formation of a double salt with the unaltered silver salt left in the film, and when the hypo is present in sufficient excess the double salt formed is highly soluble in water and diffuses readily out of the film in washing. If, however, the fixing bath is too weak, or the plates or prints are removed too soon, then imperfect fixing results, owing to the formation of a double salt which is almost insoluble in water. This may be shown as a simple test-tube experiment by

taking a solution of silver nitrate and one of hypo, when, on adding them together in such a manner that the former is present in excess, a white precipitate, which rapidly turns brown and finally black, is the result, the reäction being expressed by the following equations :—

$$2AgNO_3 + Na_2S_2O_3 = Ag_2S_2O_3 + 2NaNO_3.$$

Then

$$Ag_2S_2O_3 + H_2O = Ag_2S' + H_2SO_4.$$

By the addition of hypo in excess, however, the white precipitate first formed is readily dissolved and a perfectly clear solution results. Therefore care should be taken to have the fixing bath sufficiently strong and to allow the plates or prints to remain in long enough to ensure perfect fixation. In other words, to ensure the formation of the double thiosulphate of silver and sodium, which is highly soluble, a reäction expressed by the equation :—

$$2AgBr + 3Na_2S_2O_3 = Ag_2Na_4(S_2O_3)_3 + 2NaBr.$$

ACID FIXING BATHS.—The use of an acid fixing bath has certain advantages over that of a plain solution of hypo in water, inasmuch as the bath keeps clean for a much longer time and the plates are quite free from any deposit or stain in the film. Their preparation requires care to avoid any precipitate of sulphur taking place due to decomposition of the hypo by the acid. A very good formula for such a bath, "originally given by Mr. Sandell for fixing his double- and triple-coated plates," is the following :—

Hypo	7 ounces
Soda Sulphite	1 ounce
Water	20 ounces
Strong Sulphuric Acid	1 drachm

After the hypo and soda sulphite are dissolved the sulphuric acid is added in drops at a time, stirring all the while. Such a fixing bath keeps quite a long time and may be diluted or not as thought desirable. Another bath, containing meta-bisulphite of potassium, is as follows :—

Hypo	5 ounces
Potassium meta-bisulphite	2½ ,,
Water	20 ,,

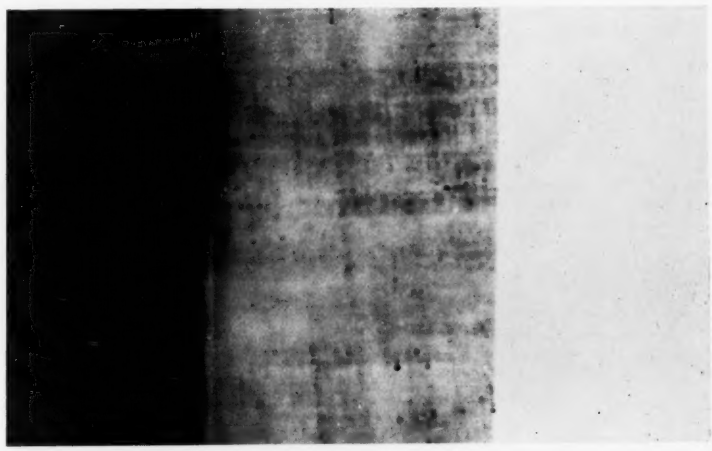
An acid fixing bath, containing common alum, can be prepared by taking certain precautions in mixing. The following will be found a very good formula :—

Hypo	4 ounces
Soda sulphite	1 ounce
Common alum	½ ,,
Tartaric acid	60 grains
Water	20 ounces

The ingredients must be dissolved in the order given, as, supposing the soda sulphite were to be added last, it would be found that the alum and tartaric acid would reäct with the hypo and a precipitate of sulphur would result.

A good plan is to dissolve the hypo and sulphite in a part of the water and the alum and tartaric acid in the remainder. The alum is then added to the solution of hypo and soda sulphite and finally the tartaric acid solution is poured slowly into it, stirring all the while. A precipitate which first forms will be found to dissolve up completely, and the acid solution will remain quite clear. This fixing bath possesses considerable hardening properties when freshly made, which, however, decrease rapidly by keeping.

TESTING DARK-ROOM LIGHT FILTERS.—One frequently sees an otherwise good negative completely spoilt through undue exposure of the plate during manipulation to the light from the dark-room lamp. If we remember that there is probably no such thing as an absolutely safe light—it simply being a question of the length of time a plate may be exposed without showing any effect due to this cause—it is evidently advisable that some kind of test should be made to ascertain it. Of course, the spectrum test is valuable in showing the region of the light transmitted by the material used as a filter, but then the general sensitiveness, as well as the spectrum sensitiveness of the emulsion, has to be taken into consideration also. And it is found that a light which is perfectly safe to employ with a plate of low sensitiveness would not be so for one of the opposite nature. In fact, a plate may be orthochromatic, but its general sensitiveness so low that it may be developed in a yellow light, without any bad result following from so doing. The question naturally arises then as to what test should be applied to ascertain the safety or otherwise of the medium in use for the purpose of filtering the light through. The one employed by the writer is due to Sir William Abney, and consists in exposing a plate behind several different kinds of coloured glass, paper, or fabrics to the light used as the source of illumination for periods varying with the nature of the emulsion on the plate. A test of this kind is shown in Figure 234, the material used being (*a*) canary medium, (*b*) cherry fabric, (*c*) orange paper. These were fastened together and placed upon a piece of clear glass in a printing frame, and a special rapid gelatine plate, 225 H and D, laid upon them. The whole was then exposed to the light from a sixteen-candle power incandescent electric lamp for a period of two minutes at a distance of two feet from the light. The plate was then developed in darkness, the time allowed being five minutes. Examination showed that practically no action had taken place upon that part of the plate under the orange paper, while the cherry fabric had allowed sufficient light to pass to cause considerable action on the surface beneath it, while that part of the film protected by the canary medium was, as might be expected, practically black. Instead of fixing the image, the film was simply washed and then placed in a solution of bichromate of potash, made acid with sulphuric acid. This quickly dissolved out the reduced silver, and after a thorough washing in running water the plate was brought into the light and redeveloped with amidol. By adopting this method the necessity of making a transparency in the usual manner is done away with and we at once get the relative effects produced shown in their correct aspect of light and shade, and the test furnishes the information that one thickness of orange paper employed in front of a sixteen-candle power electric lamp would practically afford such safety that a gelatine plate



A B C

FIGURE 234. Photographic test of the safety of dark room light filters.

XUM

of 225 H and D might be exposed at a distance of two feet for two minutes to the light transmitted by it without showing any fog on that account. Tests of this kind are valuable in conjunction with spectroscopic ones from the quantitative estimation of the time required to produce any action. Of course, the time could be still further prolonged by exposing further away, and so taking advantage of the greater distance. But two minutes are ample for all practical purposes, and by keeping the developing dish covered during development no trouble could possibly occur through any fault of the dark-room light. Unfortunately, orange paper varies very much in colour as well as thickness, but that which is fairly stout and of a dark tint should be chosen, and then tested after the manner described. It will be noticed that the cherry fabric is rather uneven in texture and also has a good number of pin-holes in it, so that either two thicknesses would have to be used or a combination made with canary medium, when a fairly safe light would result for plates of average rapidity.

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

THE HALL EFFECT.—Metals have the power of conducting electricity and also heat; their conductivity, however, varies with the nature of the metal; some metals, such as tellurium, are feeble conductors, others, such as copper, offer very low resistance indeed. The connection between conductivity of electricity and that of heat is not at once evident, though on the whole the thermal conductivity varies similarly to the electrical with the nature of the metal. Electricity, according to modern views, is conveyed along a conductor by the electrons which pass from atom to atom. Heat is conveyed as an increase in the kinetic energy of the molecules of the substance; but since the agitation of the molecules increases, so does the agitation of the particles contained within them, *viz.*, the electrons, and part of the thermal energy conveyed along the conductor is due to the increased kinetic energy of the electrons. This is especially the case for the metals; substances, such as sulphur, which are bad conductors, conduct heat chiefly by the motion of the molecules. It is possible to calculate approximately from such considerations what the ratio of thermal conductivity to electrical conductivity should be, and the ratio κ/σ at 10° to the ratio κ/σ at 18° should be constant and have the value 1·28. The results of experiments show that such a ratio is approximately constant for many different metals—a remarkable confirmation of the theory.

Now if electricity is conveyed along a wire by the free electrons which carry a negative charge, a magnetic field should deflect such electrons across the breadth of the conductor, and so one side will acquire a negative charge of electricity. At the same time a diffusion of such charged particles will take place from crowded parts to those less crowded, and equilibrium will be attained when the effect due to diffusion counterbalances that due to the deflection of the electrons by the magnetic field, a difference of potential between the upper and lower edges of the conductor being the result. Such a difference of potential was observed by Hall in 1879, and has since been studied by Nernst and others. Experiments have been very difficult, as several effects come into play besides the Hall effect.

Kammerlingh Onnes, of Leyden, whose experiments on liquefaction of gases are well known, has recently investigated the Hall effect at very low temperatures. The effect obtained in the case of bismuth can be divided into two components: the effect due to the magnetic field, which always gives a negative charge, due to the deflection of the electrons; the other effect is a thermal effect inversely proportional to the absolute temperature, which may reverse the sign of the charge due to the magnetic field. Results of considerable importance to the electron theory of metallic conduction may be expected from such experiments.

THE ROYAL SOCIETY'S CONVERSAZIONE.—On May 7th the Royal Society held its conversazione, at which many interesting exhibits were on view. Among such exhibits may be mentioned the new lines which Professor Fowler has found in the spectrum of hydrogen. Lines which have only previously been seen from investigations of the spectrum of the stars have been found when a very strong condenser discharge is passed through a mixture of helium and hydrogen. Another interesting exhibit was the micromanometer of Mr. Fry, who arranges a stretched membrane so that its movement twists a mirror suspended in a special manner: the pressure differences being indicated by the deflection of a spot of light, a difference of pressure of one-millionth of a millimetre of mercury can be detected.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

SPOTTED NEGROES.—Q. I. Simpson and W. E. Castle put on record an interesting peculiarity in human skin colour, "which made its appearance as a mutation or sport in a negro family of the southern United States some sixty years ago, and has shown itself fully hereditary through two generations of offspring." The peculiarity is "piebaldness," the dark skin being spotted with white in a fairly definite pattern. The original "mutant" was born in 1853, and her parents were normally coloured negroes. She married a normal negro, and had fifteen children, all of whom are living. The spottedness behaves like a Mendelian character—as a simple dominant, "the only peculiarity of the case being the excess of spotted grandchildren over the expected one-half." Some of the spotted descendants are now connected with "museums," and the authors note that the piebaldness, being an economic asset, is not likely to interfere with their racial increase.

CLIMBING FISHES.—It is well-known that the tropical fish, *Periophthalmus*, like its relative *Boleophthalmus*, spends hour after hour out of water, squatting on the mud by the sides of the tropical estuaries, or even climbing up on the roots of the mangrove trees. But such climbing powers as *Periophthalmus* possesses are far surpassed by a catfish *Arges marmoratus*, which lives in the torrential rivers of the Andes, where there is a rapid succession of falls, cascades, and pot-holes. Under usual conditions *Arges* is a clumsy and awkward swimmer, but for creeping and climbing in the torrents it is wonderfully adapted. It anchors itself by its suctorial mouth, and works itself upstream with the help of a ventral bony plate bearing the ventral fins and equipped with strong muscles which move it backwards and forwards. The plate is studded with small sharp teeth pointing backwards. The fishes climb up the smooth water-worn surfaces of deep pot-holes, and have been known to ascend eighteen feet without a slip or fall.

NOTICES.

ROYAL INSTITUTION.—The President has nominated the following gentlemen as Vice-Presidents for the ensuing year:—Dr. Henry E. Armstrong, the Right Hon. A. J. Balfour, J. H. Balfour Browne, Esq., Sir William Crookes, Dr. Donald W. C. Hood, the Right Hon. Sir James Stirling, Sir James Crichton-Browne (Treasurer), and Alexander Siemens, Esq. (Secretary).

SECONDHAND BOOKS ON NATURAL HISTORY.—More than nine hundred and fifty books on Natural History are included in Messrs. Henry Sotheran & Co.'s recent catalogue, numbered 736. The prices appear to be most reasonable and the volumes are on view at 43, Piccadilly.

THE FACE OF THE SKY FOR JULY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 41.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
July 4	6 51·6	N. 22·9	7 10·7	N. 27·3	8 41·4	N. 18·7	3 38·9	N. 16·1	18 56·9	S. 22·9	20 36·3	S. 19·3
,, 9	7 12·2	22·4	11 53·3	N. 0·6	9 0·2	16·4	3 58·6	17·2	18 54·2	23·0	20 35·6	19·3
,, 14	7 32·6	21·7	16 16·4	S. 26·2	9 12·3	14·4	4 19·2	18·3	18 51·4	23·0	20 34·8	19·4
,, 19	7 52·7	20·9	20 55·3	S. 21·1	9 18·5	12·7	4 40·5	19·2	18 48·8	23·1	20 34·0	19·4
,, 24	8 12·7	20·0	0 34·0	N. 5·0	9 16·5	11·7	5 2·5	20·0	18 46·2	23·2	20 33·2	19·5
,, 29	8 32·4	N. 18·8	4 39·5	N. 27·2	9 7·2	N. 11·6	5 25·1	N. 20·6	18 43·9	S. 23·2	20 32·4	S. 19·5

TABLE 42.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
July 4	− 1·4	+3·3	97·6	+ 6·5	−6·9	−1·6	83·0	256·4	7 34 *e*	2 35 *e*
,, 9	+ 0·9	3·8	31·5	+21·9	6·6	1·6	153·2	298·4	5 39 *e*	11 37 *e*
,, 14	3·2	4·3	325·3	+ 9·5	6·3	1·6	223·3	330·4	3 44 *e*	10 45 *e*
,, 19	5·4	4·8	259·1	−15·0	6·0	1·6	293·3	2·3	11 40 *e*	9 52 *e*
,, 24	7·6	5·2	192·9	−21·7	5·8	1·6	3·3	34·1	9 45 *e*	9 0 *e*
,, 29	+ 9·6	+5·6	126·8	− 7·5	−5·5	−1·6	73·2	65·8	7 51 *e*	8 7 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, L_1 refers to the equatorial zone; L_2 to the temperate zone; T_1, T_2 are the times of passage of the two zero meridians across the centre of the disc; to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN has now commenced his Southward march. Sunrise during July changes from 3.49 to 4.23; sunset from 8.18 to 7.49. Its semi-diameter increases from 15′ 45″ to 15′ 47″. It is at its greatest distance from the Earth at midnight on July 3rd. Outbreaks of spots in high latitudes should be watched for.

MERCURY is an evening star, reaching East Elongation on July 7th, when it is 16° from the Sun. Illumination one-half on 1st, one twenty-fifth on 30th. Semi-diameter increases from $3\frac{1}{2}$″ to $5\frac{1}{2}$″.

VENUS is a morning star, reaching West Elongation July 4th, when it is 46° from the Sun; $7\frac{1}{2}$° South of Moon on 30th. Semi-diameter diminishes from 12″ to 9″. At beginning of month one-half of disc is illuminated; at end of month five-eighths. Being South of Sun till the 24th, it is less well placed for Northern observers than it was as an evening star; after that its position is favourable.

THE MOON.—New $4^d\ 5^h\ 6^m\ m$; First Quarter $10^d\ 9^h\ 37^m\ e$; Full $18^d\ 6^h\ 6^m\ m$; Last Quarter $26^d\ 9^h\ 59^m\ m$. Perigee $6^d\ 12^h\ e$, semi-diameter 16′ 24″. Apogee $22^d\ 7^h\ e$, semi-diameter 14′ 46″. Maximum Librations, 1^d 6° E, 3^d 7° S., 14^d 5° W., 16^d 7° N., 28^d 7° E., 30^d 7° S. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 43.)

TABLE 43. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1913.			h. m.		h. m.	
July 1	BAC 1170	5·5	1 38 *m*	119°	2 12 *m*	201°
,, 1	26 Tauri	6·6	—	—	2 42 *m*	289
,, 1	BD+23°569	6·8	—	—	3 10 *m*	267
,, 6	8 Leonis	5·9	8 38 *e*	111	9 28 *e*	300
,, 8	82 Leonis	6·7	9 31 *e*	126	—	—
,, 8	83 Leonis	6·3	10 16 *e*	149	—	—
,, 13	b Scorpii	4·7	11 27 *e*	108	—	—
,, 21	39 Aquarii	6·2	0 50 *m*	349	1 20 *m*	305
,, 23	BAC 47	7·3	—	—	10 44 *e*	305
,, 23	BAC 57...	6·3	10 20 *e*	72	11 22 *e*	226
,, 25	70 Piscium	7·8	—	—	0 42 *m*	305
,, 25	ϵ Piscium	4·5	0 18 *m*	38	1 22 *m*	254
,, 26	27 Arietis	6·4	10 43 *e*	67	11 37 *e*	243
,, 28	BAC 1055	6·9	—	—	0 40 *m*	187
,, 28	66 Arietis	6·1	2 5 *m*	37	3 0 *m*	272
,, 29	χ Tauri...	5·3	1 18 *m*	88	2 12 *m*	235

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

XUM

MARS is a morning Star, but not yet well placed for observation.

JUPITER is in opposition on July 5th. Polar semi-diameter, $21\frac{1}{2}''$.

TABLE 44.

Day.	West.	East.	Day.	West.	East.
July 1	32 ⊙ 4		July 17	1 ○ 324	
,, 2	3 ○ 124		,, 18	2 ○ 134	
,, 3	1 ○ 234		,, 19	12 ○ 34	
,, 4	2 ○ 413		,, 20	○ 3124	
,, 5	14 ○ 3	2●	,, 21	312 ⊙	
,, 6	43 ○ 12		,, 22	342 ○ 1	
,, 7	4321 ○		,, 23	431 ○ 2	
,, 8	432 ⊙		,, 24	41 ○ 32	
,, 9	43 ○ 12		,, 25	42 ○ 13	
,, 10	41 ○ 23		,, 26	412 ○ 3	
,, 11	42 ○ 13		,, 27	4 ○ 312	
,, 12	41 ○ 3	2●	,, 28	431 ⊙	
,, 13	⊙ 412		,, 29	324 ○ 1	
,, 14	312 ○ 4		,, 30	31 ○ 24	
,, 15	32 ○ 14		,, 31	⊙ 24	3●
,, 16	3 ○ 24	1●			

Configuration at $11^h e$ for an inverting telescope.

Satellite phenomena visible at Greenwich, $1^d\ 2^h\ 1^m m$ I. Oc. R., $8^h\ 44^m e$ I. Sh. I., $8^h\ 49^m e$ I. Tr. I., $11^h\ 2^m e$ I. Sh. E.. $11^h\ 7^m e$ I. Tr. E.; $2^d\ 8^h\ 27^m e$ I. Oc. R.; $4^d\ 2^h\ 19^m m$ II. Sh. I.. $2^h\ 23^m m$ II. Tr. I.; $5^d\ 8^h\ 29^m e$ II. Oc. D., $11^h\ 15^m\ 38^s$ II. Ec. R.; $6^d\ 10^h\ 19^m$ III. Tr. E., $10^h\ 27^m$ III. Sh. E.; $8^d\ 1^h\ 26^m m$ I. Oc. D., $3^h\ 45^m\ 52^s$ I. Ec. R., $10^h\ 33^m e$ I. Tr. I., $10^h\ 38^m e$ I. Sh. I.; $9^d\ 0^h\ 51^m m$ I. Tr. E., $0^h\ 56^m m$ I. Sh. E., $10^h\ 14^m\ 26^s e$ I. Ec. R.; $12^d\ 10^h\ 42^m e$ II. Oc. D.; $13^d\ 1^h\ 51^m\ 47^s$ II. Ec. R., $10^h\ 19^m e$ III. Tr. I., $11^h\ 10^m e$ III. Sh. I.; $14^d\ 1^h\ 36^m m$ III. Tr. E., $2^h\ 27^m m$ III. Sh. E., $8^h\ 34^m e$ II. Tr. E., $9^h\ 2^m e$ II. Sh. E.; $15^d\ 3^h\ 10^m m$ I. Oc. D.; $16^d\ 0^h\ 17^m m$ I. Tr. I., $0^h\ 33^m m$ I. Sh. I., $2^h\ 35^m m$ I. Tr. E., $2^h\ 51^m m$ I. Sh. E., $9^h\ 37^m e$ I. Oc. D.; $17^d\ 0^h\ 8^m\ 56^s m$ I. Ec. R., $9^h\ 1^m e$ I. Tr. E., $9^h\ 19^m e$ I. Sh. E.; $20^d\ 0^h\ 58^m m$ II. Oc. D.; $21^d\ 1^h\ 37^m m$ III. Tr. I., $8^h\ 47^m e$ II. Sh. I., $9^h\ 35^m e$ IV. Tr. I., $10^h\ 49^m e$ II. Tr. E., $11^h\ 37^m e$ II. Sh. E. $22^d\ 0^h\ 25^m m$ IV. Tr. E., $1^h\ 22^m m$ IV. Sh. I.; $23^d\ 2^h\ 2^m m$ I. Tr. I., $2^h\ 27^m m$ I. Sh. I., $11^h\ 21^m e$ I. Oc. D., $24^d\ 2^h\ 3^m\ 30^s m$ I. Ec. R., $8^h\ 28^m e$ I. Tr. I., $8^h\ 35^m\ 53^s e$ III. Ec. R., $8^h\ 56^m e$ I. Sh. I., $10^h\ 46^m e$ I. Tr. E., $11^h\ 14^m e$ I. Sh. E.; $25^d\ 8^h\ 32^m\ 10^s e$ I. Ec. R.; $28^d\ 10^h\ 16^m e$ II. Tr. I., $11^h\ 23^m e$ II. Sh. I.; $29^d\ 1^h\ 6^m m$ II. Tr. E., $2^h\ 13^m m$ II. Sh. E.; $30^d\ 8^h\ 23^m\ 43^s e$ II. Ec. R.; $31^d\ 1^h\ 6^m m$ I. Oc. D., $10^h\ 13^m e$ I. Tr. I., $10^h\ 51^m e$ I. Sh. I.

Near the time of opposition, the satellites, when crossing the disc, are very close to their shadows.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Dec.	Remarks.
	°	°	
May 30 to Aug.	333	+ 28	Swift, streaks.
,, to July ..	252	− 21	Slow, trains.
June to Aug....	310	+ 61	Swift, streaks.
,, to Sep. ..	335	+ 57	Swift.
,, to July ..	245	+ 64	Swift.
,, to Aug....	303	+ 24	Swift.
July 6-22 ..	284	− 13	Very slow.
,, 15-31 ...	23	+ 43	Swift, streaks.
,, 19 ...	315	+ 48	Swift, short.
,, 22-27 ...	335	+ 51	Swift, streaks.
July to Aug...	308	− 12	Slow, long.
July 25 to Sept. 15	48	+ 43	Swift, streaks.
July 28 ...	339	− 11	Slow, long. The July Aquarids, a conspicuous shower.
July to Sept...	335	+ 73	Swift, short.
July 8-31 ..	317	+ 31	Swift, white.
July to Aug....	280	+ 57	Slow, short.
July to Oct. ...	355	+ 72	Swift, short.

The Perseids may be seen from July 19th, radiant $23^\circ + 52^c$, advancing 1° per day in R.A.

TABLE 45. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.			d.	
R Herculis	16 2	+18°·6	8·0 to 14	317·7	June 23.
RR Herculis	16 2	+50 ·7	7·8 to 9·5	241	May 9.
U Serpentis	16 3	+10 ·2	8·3 to 14	237·2	July 15.
SX Herculis	16 4	+25 ·1	7·9 to 9·2	100·55	May 12.
W Coronae	16 13	+38 ·0	7·8 to 12	244	July 14.
V Ophiuchi	16 22	−12 ·2	6·9 to 10·8	302·5	Apr. 20.
R Draconis	16 33	+66 ·9	6·4 to 13	245·6	July 29.
Z Ophiuchi	17 15	+ 1 ·6	7·5 to 13	348	May 10.
T Draconis	17 55	+58 ·2	7·5 to 12	426	Aug. 9.
RY Herculis	17 56	+19 ·5	8·2 to 13	222·3	July 22.
T Herculis	18 6	+31 ·0	6·9 to 13	165	May 2, Oct. 13.
RY Ophiuchi...	18 12	+ 3 ·6	8·2 to 13	153·3	July 14.
W Lyrae	18 12	+36 ·6	7·3 to 12	196·5	May 28.
RS Draconis	18 40	+74 ·2	8·4 to 12	281	June 29.
SU Sagittarii	18 59	−22 ·8	8·3 to 9	88	May 18.
R Aquilae	19 2	+ 8 ·1	6·2 to 11	337	May 15.
W Aquilae	19 11	− 7 ·2	8·2 to 13	489	July 24.
R Sagittarii	19 12	−19 ·5	7·0 to 13	269	Aug. 16.
T Sagittae	19 18	+17 ·5	8·3 to 9·5	156·7	June 14.
AF Cygni	19 27	+46 ·0	7·0 to 8·0	94	May 11, Aug. 13
TY Cygni	19 30	+28 ·1	8·7 to 13	354	June 22.
RT Aquilae	19 34	+11 ·5	7·6 to 12	325	Sept. 4.
RT Cygni	19 41	+48 ·5	6·6 to 12	190·5	Mar. 22.
TU Cygni	19 44	+48 ·8	8·5 to 14	225	July 21.
X Aquilae	19 47	+ 4 ·2	8·2 to 10	348	Aug. 18.

SATURN is badly placed, having been in conjunction with the Sun on May 29th.

URANUS is in opposition on 29th. Semi-diameter, $1\frac{3}{4}''$.

NEPTUNE is too near the Sun for observation, being in conjunction on the 19th.

DOUBLE STARS AND CLUSTERS.—The tables of these given last year are again available, and readers are referred to the corresponding month of last year.

VARIABLE STARS.—Tables of these will be given each month; the range of R.A. will be made four hours, of which two hours will overlap with the following one. Thus the present list includes R.A. 16^h to 20^h, next month 18^h to 22^h, and so on.

SOLAR DISTURBANCES DURING APRIL, 1913

BY FRANK C. DENNETT.

April has yielded very little by way of disturbance upon the sun. His disc was observed every day, but spots were only recorded on four—5, 6, 7, and 22—and faculae on ten others—1, 3, 8, 9, 12, 16, 17, 20, 23 and 24—whilst he appeared free from disturbance on the remaining sixteen. The longitude of the central meridian at noon on April 1st was 260° 37′.

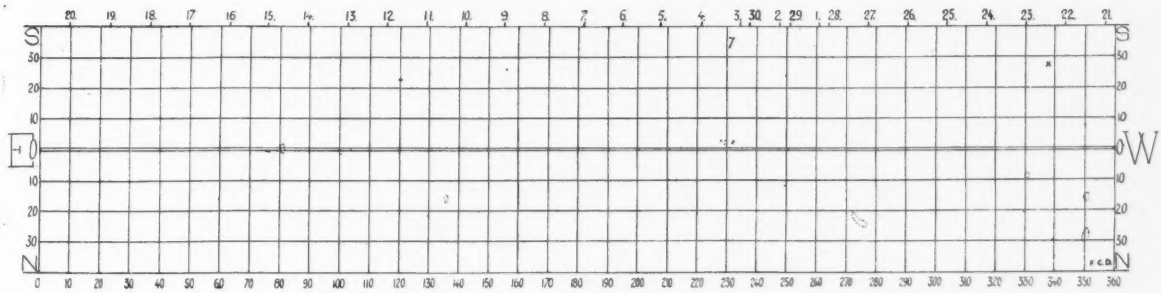
No. 7.—First seen on the morning of the 5th, as two larger and two or three smaller pores outlining the northern half of an ellipse. These smaller pores changed somewhat during the day, and the leader increased somewhat in size and became divided. The spectroscope showed only very moderate activity to the north-east of the leader, but dark hydrogen flocculi were seen, and also the presence of the dark helium line, D_3. On the 6th it had increased somewhat, being 30,000 miles in length. The area between the spots and for some distance northward looked disturbed, and this was confirmed by the spectroscope, which also showed the presence of dark hydrogen flocculi and dark helium. On the 7th only the leader remained amid a faculic display, and died out before the 8th, although the faculae remained visible until the 9th.

On the 22nd, at 3.30 p.m., there was a small but evanescent black pore situated approximately in longitude 338°, latitude 28° S. where the cross is marked on the chart, but it soon became gray, and disappeared.

A facula around 136°, 16° N. was seen on the 16th, when larger paler faculic areas were situated at 351°, 16° N., and 351°, 28° N. The latter being seen also on the 17th. A facula also seen on the 17th at 330°, 9° N. A small facula on the 20th at 81°, on, or close to, the equator. On the 22nd and 23rd a faculic area was situated at 273°, 23° N. On the 24th a pale faculic area, too faint for measurement, was round the eastern limb apparently just south-west of the place of No. 7.

The chart is constructed from the combined observations of Messrs. John McHarg, E. E. Peacock, A. A. Buss, and the writer.

DAY OF APRIL, 1913.



REVIEWS.

ASTRONOMY.

The Solar System.—By G. F. CHAMBERS. Second edition. 202 pages. 28 illustrations. 6½-in.×4¼-in.

(Hodder & Stoughton. Price 1/- net.)

This is a second edition, partly rewritten to bring it up to date, of a work first published in 1895. The present edition gives no year of publication—a frequent modern fault—but from the date of the preface one can infer that the year was 1912 or later. The book is light and of a convenient size for the pocket, also the paper and printing are both good in quality. It has thirteen chapters, of which Chapters II (Sun) and XIII (Comets) occupy seventy-five pages, or more than one-third of the whole. The chapter on the Sun, pages 21 to 62, is almost entirely devoted to Sun-spots—in fact, all but four pages, and, though very interesting reading, is out of all proportion to the rest of the chapter and book. In the next edition, which we hope to see during the author's life, we should like to have quite twenty of these pages replaced with something upon other parts of solar physics: for instance, a general account of the beautiful phenomenon of the solar corona, which can certainly be best viewed with a small, or without any, telescope, cannot be adequately given in eleven lines (eighty-one words), nor can the situation be saved by giving an antique illustration.

The remarks upon scintillations in Chapter V are very useful, interesting and suggestive; the reference to Tacchini on page 91 we can bear out from personal observations at an altitude of two miles. Likewise the reference, on page 99, to P. Smyth upon the exact similarity of terrestrial and lunar volcanoes, we can substantiate from actual rambles among the former and telescopic views of the latter. A brief reference to the excellent results of lunar photography and Saunder's work would not have been out of place. The remarks at the top of page 107 do not appear to be courteously expressed. We are glad to see the remarks on page 108 about the misuse of a revered name.

Galle does not appear to have sufficient credit given him, on pages 143 and 158, for his pioneer observations. On page 146 we notice an error in the number of satellites for Saturn. The chapters on Uranus and Neptune are concise and full of facts. There is a useful index: we noticed the omission of Aston and Titius, and the references under Satellites might have been extended with advantage. Altogether a book full of interest and facts, not fanciful, not overburdened with numbers, but pleasantly written by that veteran pen and published at such a cost that everyone should possess and read it.

F. A. B.

Annuaire Astronomique et Météorologique pour 1913.—Par C. FLAMMARION. 49ᵉ année. 404 pages. 135 illustrations. 7¼-in.×4¾-in.

(Paris: Librairie Ernst Flammarion. Price 1fr. 50.)

A book full of useful astronomical and meteorological tables and information, both for reference and for the amateur's daily use. Pages 245–390 contain a *résumé* of observations and progress in 1912, and the last pages record facts upon the scientific jubilee of Flammarion.

F. A. B.

XUM

BOTANY.

The Moorlands of North-Eastern Yorkshire. — By F. ELGEE. 356 pages. 3 maps. 71 figures. 8¾-in. × 5½-in.

(A. Brown & Sons. Price 15/- net.)

As the author rightly claims in his preface to this work, representing the results of his long-continued observations on the geology and natural history of the eastern moorlands of Yorkshire, we have here for the first time a comprehensive book dealing with a British moorland area from a scientific standpoint. The ecology of moors in various parts of Britain has been dealt with in memoirs by members of the British Vegetation Committee, while among Continental memoirs two stand out prominently—Graebner's *Heide Nord-Deutschlands* and Früh and Schröter's *Moore der Schweiz*—but the present work differs from all these in that it deals not only with the plant life of the moorland but also the geology and zoölogy in their relationship and interdependence.

The author does not claim to have produced a definite monograph, and though every aspect of the moorlands has been touched upon in his work, an exhaustive treatment of each topic has not been attempted; for instance, detailed descriptions of moorland plants and animals have been omitted, as these are found in works dealing with the British flora and fauna. By judicious selection, and owing to his having taken into account the current literature of the topics dealt with, he has produced a striking contribution to ecology, and since he indicates throughout the work the various problems in moorland ecology which are still open to solution, and upon which further search is required, the book is one that should stimulate other workers in various districts to take up some of the many questions raised. For instance, he points out that the investigation of the peat deposits, layer by layer, is a piece of research that is urgently needed, because of the light it would throw upon climatic changes in post-Glacial times and upon the development of the "mosses" (moss-moors, *Hochmoore*).

The greater part of the book is of general rather than merely local interest, since a large amount of space is given to the consideration of subjects wnich have a general bearing —the peat beds and the evidence they yield as to primitive woodland on the moors, the relationship of the moorland flora and fauna to the glaciation of the district, the origin of various geological features such as outliers and inliers, the general conditions determining the existence of moors, the origin of the moorland flora and fauna, and the relations of the moorland fauna to the flora. "The scope of the work," to quote from the author's statement in the introductory chapter, "is to exhibit the interdependence of all aspects of the moors: their antiquities, plants, rocks, insects, stones, birds, and climate form a coherent whole which cannot be fully understood unless all are considered. We shall regard the moors as a unique assemblage of factors of intense interest, which owe their present status to innumerable causes that have been operating for ages. In other words, we shall follow that sequence of events which has led to the evolution of the moorlands of North-Eastern Yorkshire." In this introduction a general account is given of the general physical features and the geology of the district.

In Chapter I the author discusses the antiquities of the moorland, with some interesting notes on the etymology of the terms "moor," "heath," and so on. On various grounds it is concluded that from early times, perhaps three thousand years ago, the high moors were never clothed with trees. Chapter II deals with the "fat moors"—the typical heather moor, or heath, with a well-developed peat-layer, often of considerable thickness—as contrasted with the "thin moors" considered in Chapter III, where the peat is thin and the different associations are dominated by *Calluna*, *Erica* spp., *Scirpus caespitosus*, *Molinia* and *Nardus* and other heath grasses, *Ulex*, and so on. Chapter IV is concerned with "mosses"—*Sphagnum* bog, cotton grass moor ("Eriophoretum vaginati"), and so on; Chapter V with the moorland slopes, including associations dominated by bracken, birch woods, oak-birch woods, larch and pine-woods, bilberry slope, rush bogs with *Sphagnum*, and so on; Chapter VI with the interesting "slacks" and "gills" (small valleys with broad flat streamless floors and steep slopes) which often present a remarkable congestion of plant associations, so that many of the types of moorland vegetation may be found within a limited area. In connection with the "slacks" the author gives an interesting summary of recent work on the plant remains in peat deposits in Britain, and concludes that for many thousands of years, probably even since the Ice Age itself, the moors were islands and peninsulas of heath vegetation, surrounded by a great sea of forest and woodland, feelers of which penetrated far into the heart of the uplands along the sides of the streams. This subject is developed more fully in Chapter VII, which is devoted to the geological effects of the Ice Age on the moors, with an account of Professor Kendall's investigations on the former glacier lakes of the district.

The origin of the moorland flora is next discussed (Chapter VIII), and the conclusion reached is that the geological history and geographical distribution of the chief moorland plants proves that the moors were formed in pre-Glacial times, probably towards the close of the Pliocene period. This leads to a further discussion in Chapter IX of the Ice Age and the moorland flora, the history of the latter being summed up in the following stages: (1) Evolution of *Vaccinium* spp., *Eriophorum*, *Empetrum*, and so on, in a northern land in Pliocene times, and a gradual dispersal of these species southwards with the approach of the Ice Age; (2) origin of *Calluna* and *Erica* spp. in South-Western Europe and their dispersal north and east during the Pliocene period; (3) advent of the Ice Age with survival of most of the northern species on the driftless area—*Erica cinerea*, *E. Tetralix*, *Myrica Gale*, and *Pteris aquilina*, however, probably driven from the district; (4) post-Glacial re-entrance of these four plants, and development of moors from the Arctic plant communities of the uplands and upon the bare ground; (5) a warmer and drier climate with a decline of wet moors and the growth of trees in the slacks, gills, and dales and on slopes and parts of the higher moors; (6) an increased rainfall with an acceleration of moor formation, and a destruction of the birch and oak woods in the slacks and gills by the development of peat bogs; (7) the present moors, where peat formation and destruction counterbalance each another.

Then follow four chapters of mainly geological interest, and the work concludes with three extremely interesting and suggestive chapters on animal life (in particular insect life) on the moors, containing the results of the author's patient and successful investigations in a field which has been comparatively little worked at, and a finely written general conclusion, in which the author skilfully gathers up the threads of the work and emphasises the importance of his main theme—the interdependence of the various factors which condition the moorland climate, physiography, flora, and fauna. Extensive tables are appended, giving the chief facts regarding the moorland lepidoptera divided into two groups according to whether the food plants are *Calluna* and *Erica* or *Vaccinium*. This portion of the book forms a mine of information concerning the insect fauna of moorlands and its relation to the flora.

There are two large maps coloured to show the geological formations and the distribution of moorland respectively in north-east Yorkshire, and a map of typical geological sections. Of the photographic plates with which the book is lavishly illustrated all are excellent and many are particularly fine. This book will certainly rank as a standard work on British vegetation, and it is to be hoped that the successful publication of a work of this scope will be followed by the production of other books dealing in a similar manner with the vegetation of larger or smaller areas of the British Isles.

By the courtesy of the publishers we reproduce here two of the plates illustrating Mr. Elgee's work (see Figures 235 and 236).

F. C.

From a photograph FIGURE 235. *by Frank Elgee.*

Birch Wood and Juncus Swamp, Eston Hills, Yorkshire.

From a photograph FIGURE 236. *by Frank Elgee.*

Loose Howe, Rosedale Head, Yorkshire.

From "The Moorlands of North Eastern Yorkshire."

Economic Woods of the United States.—By SAMUEL J. RECORD, M.A., M.F. 117 pages. 6 plates. 9¼-in.×6-in.

(Chapman & Hall. Price 5/6 net.)

This book is most complete for a somewhat condensed work on the subject, and is offered at a very reasonable price. It refers to U.S.A. timber trees only, but a large number of these are important to us owing to their commercial uses and also in several cases to their value for planting in this country. The book is well arranged; each point is dealt with in a businesslike and concise manner, and with as little repetition as possible. The language is clear, and it is refreshing to find no peculiar American phraseology or spelling.

Part I deals with the structural and physical properties of wood, and contains much of interest to the student in technology, the forester and the commercial user of timber. Although many of the points are of necessity dealt with in a somewhat condensed form the ground is well covered, and after each heading is given a list of textbooks referred to and from which more detailed information can be procured where desired. A complete list of references, including the standard books of each branch, is published at the end.

Part II is a key with photomicrographs of some of the American timbers, and is useful for showing the main characteristics in structure; but it is somewhat limited in its application.

The work, although not intended to be original, brings together a mass of useful information, and, taken altogether, is a welcome and valuable addition to the literature on the subject. It should appeal to those who require a general grasp and have neither the time nor the means to go deeply into every point.

M. C. D.

GEOLOGY.

The Petrology of the Sedimentary Rocks.—By F. H. HATCH and R. H. RASTALL. 425 pages. 60 figures. 7½-in.×5-in.

(G. Allen & Co. Price 7/6 net.)

The petrology of the sedimentary rocks has been much cultivated lately, and although it was neglected in the early days of the science compared with the igneous and metamorphic branches, it is now coming into its own. This book represents a culmination of interest in which sedimentary petrology threatens to rival the other branches in its attraction for workers. The literature of the subject is large and scattered, and the authors are to be congratulated on their successful attempt at its collation in the book under review, which is the first of its kind. The title scarcely records the scope of the work, since the majority of rocks usually treated as metamorphic are also described. The term "metamorphism" is used in its widest sense to indicate all sorts of change in rocks, cementation, metasomatism, and weathering, as well as the severer forms due to great heat and pressure which result in the production of rocks included as metamorphic in the narrower sense. There are certainly no sharp boundaries between the various types of change, and logically, therefore, the plan of the book is unassailable. We think, however, that the inclusion of the metamorphic rocks might have been more prominently indicated in the title; or alternatively they might have been relegated to another volume. The use of the term "metamorphic" in such a wide sense involves the incongruity that our typical sedimentary rocks, such as sandstone, shale, and limestone, are treated in the second part of the book under the heading "Metamorphic Derivatives of the Sediments," and the cursory student may be somewhat at a loss on finding their descriptions in this place. It is to be admitted, however, that, given the definition of metamorphism here adopted, the arrangement of the book is perfectly logical.

In the first part of the book the modern sediments are dealt with under the headings of "Deposition in General," "Fragmental Deposits," "Chemical Deposits," and "Organic Deposits." In Part II the older sediments which have undergone various types of change are described under the headings "Metamorphism in General," "Cementation and Metasomatism," "Contact Metamorphism," "Regional Metamorphism," and "Weathering." In these chapters very lucid accounts of the methods of deposition and the modes of change in the sediments are given. In fact the book is really a well-knit and concise account of the petrogenesis of the sedimentary rocks. Because of this fact, and perhaps also because of its limited size, the book is a little disappointing on the petrographical or descriptive side. Its plan also involves some discontinuity of treatment for sediments which are related in various ways. The calcareous rocks, for instance, excluding the metamorphic types, are to be found under three headings. The ordinary sedimentary limestones in general appear to be inadequately described as compared with the sandstones and shales. Referring to the index we find five entries under "limestone," but four of these refer to metamorphic types and the other to cave-limestone. In other parts of the index we find additional references to crinoidal limestone, dune-limestone, and dolomite, but none to oölitic limestone. Then no description of the ways in which the various organisms which build limestones may be recognised is given.

These, however, are but small spots on the sun of the general excellence of the book, and inasmuch as the authors have in our opinion accomplished what they set out to do, and have produced a most interesting and important work, they are entitled to all praise. They have been fortunate enough to secure a most useful appendix, by Mr. T. Crook, on "The Systematic Examination of Loose Detrital Sediments," in which are described the methods of separating and identifying minerals in small fragments.

G. W. T.

A Manual of Petrology.—By F. P. MENNELL. 256 pages. 124 figures. 9-in.×5½-in.

(Chapman & Hall. Price 7/6 net.)

This book is based on the author's "Introduction to Petrology," the second edition of which was reviewed in "KNOWLEDGE" of August, 1910. It differs from the earlier book in several particulars. The chapters on the origin of igneous rocks and on metamorphism have been remodelled, and the position of some chapters has been altered. Many of the illustrations are new, and, as a whole, are decidedly better than in the former work. We wish we could say the same of the classification of igneous rocks adopted. Mr. Mennell "simplifies" petrological nomenclature by classifying igneous rocks into five groups according to silica percentage, and each of the latter into three divisions of plutonic, intrusive, and effusive types respectively. By this method he gets fifteen classes, for which fourteen names are supplied, the ultrabasic plutonic rocks (*i.e.*, those with less than forty-five per cent. of silica) not being provided with a name. Varieties are indicated by mineralogical prefixes. It is a delusive simplification, however, which reduces the nomenclature of a science, for progress or increasing complexity demands an increasing nomenclature. In particular the silica percentage is an extremely artificial attribute on which to base a classification. Thus, for example, to call all plutonic rocks with a silica percentage between fifty-five and sixty "diorites," and thus to include the majority of nepheline-syenites, is merely to introduce confusion, just as it would introduce confusion to call all marine animals "whales," or all land animals "elephants," on the strength of a community of habitat.

The classification by silica percentage ignores the fact that rocks are composed not of silica percentages, or of percentages of various oxides, but of minerals. Hence the mineralogical variations in rocks are the most significant variations, and should be those expressed in the major divisions of the classification. Not less, but more, nomenclature is needed for the philosophical discussion of petrological principles. What is needed is not a reckless aggregation of, for example, such unlike units as nepheline-syenite and diorite into one group, but a more subtle and closer characterisation of igneous types leading to a more detailed classification.

In this book the classification by silica percentage leads to

such anomalies as the inclusion of ditroite in the diorite group (page 144); the treatment of kentallenite and borolanite under that very accommodating term "dolerite" (page 156); and the use of such a term as "nepheline andesite," which is almost a contradiction in terms if the ordinary definition of andesite is to stand. If there is one rock that can be said never to contain nepheline that rock is andesite; and it does not mend matters when we find that by "nepheline andesite" the author means "phonolite." Hence, so far as the classification of igneous rocks is concerned, this book cannot be recommended to the student, who, since he has to identify his rocks by their mineralogical content, and is rarely able to determine their silica percentage, would be led into hopeless confusion.

The chapter on the origin and variations of the igneous rocks is interesting and provocative of thought, although very speculative. The sedimentary and metamorphic rocks are also treated in a thoughtful and useful manner. Indeed the rest of the book is so good that it is a pity the author does not see fit to bring his views on the classification of igneous rocks more into accordance with the experience of the great majority of petrologists.

G. W. T.

MICROSCOPY.

The Beginner's Guide to the Microscope.—By CHAS. E. HEATH. 119 pages. 46 illustrations. 7-in. × 5-in. (Percival Marshall. Price 1/- net.)

The microscope is now used in connection with so many different matters and the advantages of the training which it gives to hand, eye, and brain are so widely recognised that a book such as the present one, which tells in simple language what the microscope is, and how it can be used, is worthy of the most cordial welcome. We think that in this beginner's guide the author has just happily chosen those points of the greatest value and he has not gone into such detail as to bore those for whom he writes. His advice, too, is sound; as, for instance, when he urges the beginner who wishes to get a good microscope to buy no instrument nor objective that does not bear the name of a recognised maker.

W. M. W.

By the courtesy of *Mr. Rowland Ward.*

FIGURE 237.

Wapiti-red-Deer Cross, bred at Surrenden Park, showing red deer type of head, from "Deer Breeding for Fine Heads.

PHILOSOPHY.

The History of Magic, including a clear and precise Exposition of its Procedure, its Rites and its Mysteries. —By ÉLIPHAS LÉVI (ALPHONSE LOUIS CONSTANT). Translated, with a Preface and Notes, by ARTHUR EDWARD WAITE. 536 pages. 20 plates. $8\frac{3}{4}$-in. × $5\frac{3}{4}$-in.

(William Rider & Son. Price, cloth, 15/- net; vellum, 21/- net.)

A great poet* has said: "Everything possible to be believed is an image of truth." Certainly the belief in the efficacy of magical practices would not have persisted for so long had not these practices been productive of results. No doubt the phenomena thus produced must be classed as "subjective," and the question of Magic is one for psychology rather than physics. The literature dealing with the history of Magic from this point of view is, however, very slight: until the publication of this translation (by which all students are laid under a debt of gratitude to Mr. Waite) there was nothing of much importance in the English language other than Mr. Howitt's translation of Joseph Ennemoser's work.

One requires to know something of Alphonse Louis Constant to appreciate his works aright. He was lacking in the precision and accuracy of the scientific man; his reading, though wide, was careless, and he rarely, if ever, verified his quotations; he was apt to see his own theories everywhere, and it was seldom that he could resist the desire to elaborate tradition and legend. But, in spite of their many defects, his books exhibit a brilliancy of imagination and a charm of expression which render them of real value. Indeed, Constant was by no means lacking in philosophical insight, and was certainly well versed in his subject.

Magic, in Constant's terminology, was originally the absolute science of equilibrium. It degenerated, however, until it became, as it were, a disease of the imagination. Indeed, during the period of the witchcraft persecutions it became almost an epidemic, and the evil was accentuated by the fact that it was supposed that an exorcised, "devil" could not speak untruthfully, so that innocent persons were accused and convicted of the most horrible and impossible crimes on the evidence of persons suffering from nervous and mental disease. Nevertheless, according to the author, the doctrines of Magic embody profound philosophical truths, though in a distorted form. I am inclined to agree with this view; though I doubt whether Constant's assumption of a universal medium (which he fantastically calls "the astral light"), upon which the imagination can act either for good or evil, will appeal to modern psychologists.

Constant owed much to the Kabalah, *i.e.*, the books which claim to contain the secret philosophical traditions of Judaism. It is interesting to note that the cosmology of the Kabalah is definitely heliocentric, and I am inclined to think the books are worthy of more study than is devoted to them. From this source Constant derived his central doctrine of equilibrium, though he interpreted it in his own sense and applied it to every department of thought.

Mr. Waite's careful and scholarly notes, in which he corrects some of Constant's misstatements and throws

* William Blake.

further light on the obscure subject of Magic, add very greatly to the scientific value of the book.

H. S. REDGROVE.

PHYSICS.

Introductory Electricity and Magnetism.—By CARL W. HANSEL. 373 pages. 283 illustrations. 7½-in.×5-in. (William Heinemann. Price 2/6 net.)

This book is obviously the work of an experienced teacher, and deserves the careful consideration of all concerned in preparing for elementary examinations in this subject. The figures are excellent, and there is a refreshing absence of confused photographic reproductions. At the end of each section questions for revision are given.

W. D. E.

Elementary Experimental Dynamics for Schools. — By C. E. ASHFORD, M.A. 246 pages. 94 illustrations. 7¾-in.×5-in. (The Cambridge University Press. Price 4/- net.)

This useful little book scarcely needs the apology which the author makes for it in his preface. The principle of approaching the study of Kinetics by an inductive method is now fairly well established, and the arguments for it are recapitulated here. In the text itself the measurement of velocity and of small intervals of time is approached by way of Fletcher's trolley and vibrating paint-brush, and the notion of variable velocity is introduced by distance-time diagrams plotted from Bradshaw on squared paper. The notions of force and of the relation between gravitational and kinetic units of force are led up to by further experimental work with the trolley and paint-brush. An experimental verification of the formula for kinetic energy is new to us. The chapter on Fluid Pressure is a link between the past and the present of our Navy, as it deals with wind pressure on sails and also with the Parsons steam turbine. Teachers of mechanics will find many hints in this book, even if they cannot afford to invest in all the apparatus which the British taxpayer supplies to our naval colleges.

W. D. E.

YEAR BOOK.

Directory of Museums in Great Britain and Ireland; together with a Section on Indian and Colonial Museums.—By E. HOWARTH, F.R.A.S., F.Z.S., and H. M. PLATNAUER, B.Sc. 312 pages. 8¾-in.×5¾-in. (The Museums Association. Price 10/-.)

We have received a copy of the Directory of Museums, which gives briefly but in a very useful way much valuable information with regard to the National and Local Institutions of this country, as well as the more important Indian and Colonial Museums. We learn who is responsible for the various Museums, how they came into existence, what they specially intend to illustrate, as well as what work of an educational kind is carried out by the staff. The book should be in every reference library.

W. M. W.

ZOOLOGY.

Life and Evolution.—By F. W. HEADLEY. 272 pages. 98 illustrations. 8½-in.×6-in. (Duckworth & Co. Price 5/- net.)

Based on lectures delivered to the natural history class at Haileybury College, this attractive volume was first presented to the public in 1906, and its reappearance in the form of a new and revised edition affords such testimony of its popularity that commendation on our part seems superfluous.

By the courtesy of *Mr. Rowland Ward.*

FIGURE 238.

Cross-bred Altai-red-Deer, from "Deer Breeding for Fine Heads."

Among the chapters that have undergone special revision are those on flight, but when discussing (page 98) the manner in which the giant pterodactyles of the secondary epoch were enabled to sustain themselves in the air, the author appears to have overlooked an important paper published last year in the *Bulletin* of the Geological Society of France, in which Messrs. E. and A. Harlé maintain that without an atmospheric pressure much greater than at present exists flight in the case of these monstrous reptiles would have been an absolute impossibility. He might also (page 141) have referred to Sir Hiram Maxim by his proper title instead of as Mr. Maxim.

Some of the sentences in various parts of the work would also have been the better for revision, as is exemplified by the unnecessary repetition in the following statement (page 89):—"The reptile that seems to carry off the prize for speed is an Australian lizard, *Chlamydosaurus kingi*. *Chlamydosaurus* is an Australian lizard, being found in Queensland."

Apart from slight shortcomings of this nature, the book is an excellent epitome of modern views on evolution.

R. L.

Deer Breeding for Fine Heads, with Descriptions of many Varieties and Cross Breeds.—By WALTER WINANS, F.Z.S. 105 pages. 34 illustrations. 11-in.×9-in. (Rowland Ward. Price 12/6 net.)

The first object of Mr. Winans' book is to show that the Deer should be looked after and bred as carefully as any other animal which is kept in captivity. His illustrations show how well he has himself succeeded. Incidentally, however, in the book an account is given of cross-bred deer, and by the courtesy of the author we are able to show pictures of the heads of the cross between the Wapiti and red deer as well as between the Altai and red deer. Mr. Winans has gone further and crossed a Wapiti-red-Deer hind with an Altai stag, so that he has now Wapiti-Altai-red-Deer hybrids, a cross which he believes has never before been attempted. There is much of great interest and usefulness in the book, and we may allude to the chapters on the preservation of Horns; on the precautions to be taken to avoid injury by Deer, and with regard to the times of breeding. Artists should read the notes on the action of Deer and take to heart what Mr. Winans has to say about the drawing of animals.

W. M. W.

COMETS.

By F. W. HENKEL, B.A., F.R.A.S.

THESE still mysterious bodies have always been of the highest interest both to the astronomer and the "man in the street," and though the progress of science has robbed them of much of the terror their

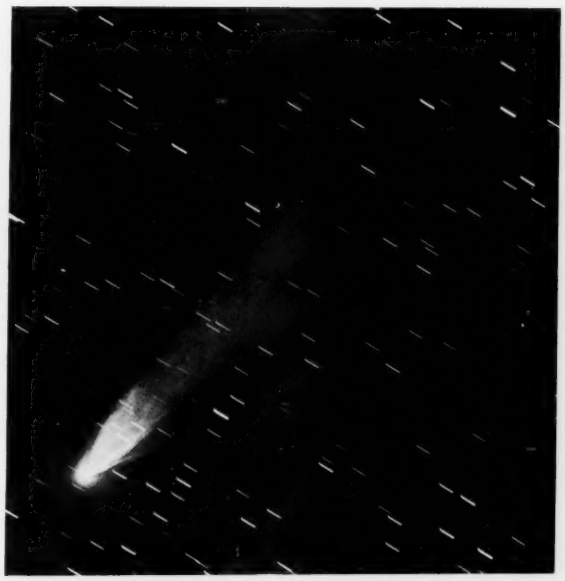


FIGURE 239. Comet 1908 III (Morehouse).

P. J. Melotte and C. R. Davidson, Royal Observatory, Greenwich. 1908, Sept. 7^d 14^h 56^m G.M.T. Position of Comet: R.A. 3^h 3^m; Decl. $+69°$ 38′. Reflector: Ap. 30-in. (0·762m); F.L. 11-ft. 5-in. (3·48m). Exp. 60 mins.

unexpected apparitions formerly inspired, whilst the calculations and verifications by returns, as well as discoveries of the last generation, have to some extent satisfied our curiosity as regards some of the phenomena presented by them, yet other problems have arisen demanding solution for which the data we at present possess are inadequate. The regular return of certain well-known comets, such as Halley's and Encke's, though on the one hand affording ample demonstration of the justice of the principles and methods employed by astronomers for the determination of their orbits, yet on the other hand, even for these comets, unexplained, though small deviations from their calculated paths afford material for speculation as to the nature of other agencies besides gravitation affecting their motion. Other comets there are, however, which have failed altogether to return, notwithstanding the great increase of accuracy in our knowledge of their orbits, whilst for those that do return, as well as for new comets, the remarkable changes of form that occur from day to day, and the extraordinary behaviour of parts of their substance when nearest the sun, seem to indicate the existence of matter in a physical condition unlike anything of which we have experience here, and from the want of such information our knowledge of cometary physics is necessarily defective. Thus, to the wonder and terror formerly inspired by a comet has succeeded the scientific wonder and curiosity at beholding the behaviour of "matter" under almost unimaginable conditions.

In early days, no doubt from the rarity and unexpectedness of their appearance and the remarkable nature of the appendages which many of them possess, comets were regarded with fear and trembling not only by the general public but also by the learned, and in fact, much of the terror of the former was due to the credence they gave to the baseless conjectures of the latter. This feeling has by no means died out, to judge from what one hears and reads with regard to recent comets, but its nature has perhaps slightly changed. Formerly such "wars, pestilences and the death of princes" as occurred shortly after the apparition of a comet were attributed on the sufficient principle of *post hoc, ergo propter hoc*, combined with the idea that all things had direct effect upon human destinies (the

FIGURE 240. Comet 1908 III (Morehouse).

E. E. Barnard, Yerkes Observatory. 1908, Oct. 1^d 19^h 15^m G.M.T. Position of Comet: R.A. 21^h; Decl. $+71°$. Bruce Doublet Lens: Ap. 6-in. (0·153m); F.L. 50·3-in. (1·28m). Exp. 65 min.

XUM

Geocentric concept of the universe), to their baleful influence; in later days for the same good reasons the weather conditions of our own earth were supposed to be modified by their presence, and examples of this are to be found in most astronomical works, as well as in our paper "Comets and the Weather" contributed to *Symons's Magazine*. Donati's comet of 1858 was thus made answerable for the hot weather prevailing that year in England, Biela's comet in 1832 similarly influenced the summer of the "year of reform," whilst the great comet of 1811 caused the ripening of the grapes in some provinces of France, resulting in one of the most wonderful vintages ever known. The same comet of 1811, appearing shortly before Napoleon's disastrous campaign in Russia, is credited with having unfavourable omens drawn from it by the Russians, but here it would appear that the omens were worse for the invading French army than for themselves. If the comet of 1769, which appeared at the time of his birth, is to be regarded as Napoleon's presiding and protecting genius, this one must be considered as his evil one. The origin of all such notions, as has been well remarked, is to be looked for in the vanity of man and his self-constituted rulers, perhaps more excusable in the days when our little earth was looked upon as the centre of the Universe than in our own, but none the less utterly without foundation. The natural desire of the human mind to resolve mysteries was satisfied by the pretended explanations of those who knew no more than their questioners, whilst the bold confession that we are all ignorant and merely as children picking up a few pebbles on the shore whilst the great ocean of truth lies unexplored (Newton) was reserved for later days. Though the encomium of Pope upon Newton

> "Nature and Nature's laws lay hid in night,
> God said, let Newton be, and all was light,"

is, of course, in excess of the truth and as we have seen, Newton himself did not think so, yet there probably has never been any work of human genius greater than the incomparable "Principia." Here, for the first time, it was definitely laid down that a body moving under the influence of a central force (such as gravitation) varying inversely as the square of its distance from the centre of force, will describe one of the conic sections, an ellipse (circle as a special case), parabola or hyperbola. It had been previously suspected that one or two comets moved in long ellipses or parabolas and Dörfel in 1680 showed that the great comet of that year moved in such a path. Newton showed that its motions were entirely in accordance with gravitational principles and the parabolic elements of its orbit were calculated according to methods given by him. This comet approached unusually close to the Sun when nearest, and for a short time must have "been heated to a temperature many times that of molten iron" (Newton). Halley considered that this comet moved not in a parabola but in a very long ellipse, giving it a period of five hundred and seventy-five years, which led Whiston in his "New History of the Earth" to speculate that it was to an earlier return of this comet that the Noachian deluge had been due, and that at a later return it would cause the destruction of our planet by fire! However, Encke's later calculations, ascribing a period of eight thousand eight hundred years to the comet, are to be preferred to Halley's result, so that Whiston's speculations need not be further considered.

FIGURE 241. Comet 1908 III (Morehouse).

P. J. Melotte and C. R. Davidson, Royal Observatory, Greenwich. 1908, Oct. 3^d 9^h 4^m G.M.T. Position of Comet: R.A. 20^h 44^m; Decl. $+ 68^\circ$ $58'$. Reflector: Ap. 30-in. (0·762m); F.L. 11-ft. 5-in. (3·48m). Exp. 30 min.

The three curves known as the conic sections; parabola, ellipse and hyperbola, as their names imply, may all be obtained by cutting a cone in different ways by a plane, but perhaps they may be more intelligibly defined to the non-mathematical as being obtainable by throwing the shadow of a circular disc upon a plane surface, such as a table. If the disc be held parallel to the table, we get a circle, if obliquely an ellipse, a closed oval curve; if we hold it edgeways to the light we have a straight line. If now we raise the disc so that its highest point is on a level with the source of light, we shall get a parabola, which is oval at one end, but the two sides open out and do not meet again. If now we hold the disc still higher, we shall get another curve, whose two sides will separate even further from the other. This curve is the hyperbola (or geometrically one branch of the hyperbola, there being another similar branch).

Whilst the planets move in ellipses little differing

from circles in most cases, the comets in general are found to move in orbits so nearly parabolic (whilst in the small part of their path during which they are visible to us), that only a few are known whose motion is otherwise, all three curves differing but little near the vertex. Thus the orbit of a newly-discovered comet is always first calculated on the assumption that its motion is parabolic; another reason being that the necessary calculations are simpler than for an elliptic or hyperbolic orbit. A strictly parabolic orbit, however, is practically impossible, for the smallest diminution of speed due to planetary action would change it into an ellipse, whilst an increase would convert it into a hyperbola. The remarkable fact that so many cometary orbits closely approximate to a parabolic form must have important bearings on any theory as to their origin, though there are reasons for suspecting that the true orbits are not really parabolic, but very long and eccentric ellipses. A comet moving in a parabola (or hyperbola) will be seen only once, never to return; whereas, one moving in an ellipse, the latter being a closed path, must return again sooner or later, though thousands, or even perhaps millions, of years may be required to complete one revolution round the sun, their centre of force; the common focus of their orbits. A very few comets have been *suspected* to move in hyperbolic orbits, but the deviation in excess of parabolic velocity is always so small, that it may reasonably be doubted whether any known hyperbolic-moving comet has been certainly detected. The vast majority appear to move approximately in parabolas, a considerable (and increasing) number in ellipses whose deviation from circularity is much greater than that of the planetary orbits, but not always so great as that of some double-star orbits.

In 1682, a comet was observed by Newton, Halley and others, and on examining the circumstances of its motion Edmund Halley computed its orbit on the supposition that the latter was a parabola. Comparing his results with former observations and computing other orbits from the necessarily imperfect determinations of position of earlier days, he found that in 1531 and 1607, comets had appeared which moved so nearly in the same path as this one that he ventured to assert its identity with them, and to predict its return in 1758 or 1759. Though he could not expect to witness this event himself he wrote on the subject: "If it should return according to our prediction about the year 1758, impartial posterity will not refuse to acknowledge that this was first discovered by an Englishman." It is well known that his prediction was completely verified, and the comet's latest return (after 1758 and 1835) is so recent that the details must be familiar to all readers of "KNOWLEDGE." The true glory of a nation, not obtained at the expense of any other, nor involving the sacrifice of precious lives, is shown more by such achievements than by deeds of homicidal conquest, and we may be justly proud of the names of our countrymen Newton, Halley, Herschel, Cowell, Crommelin, and so on,

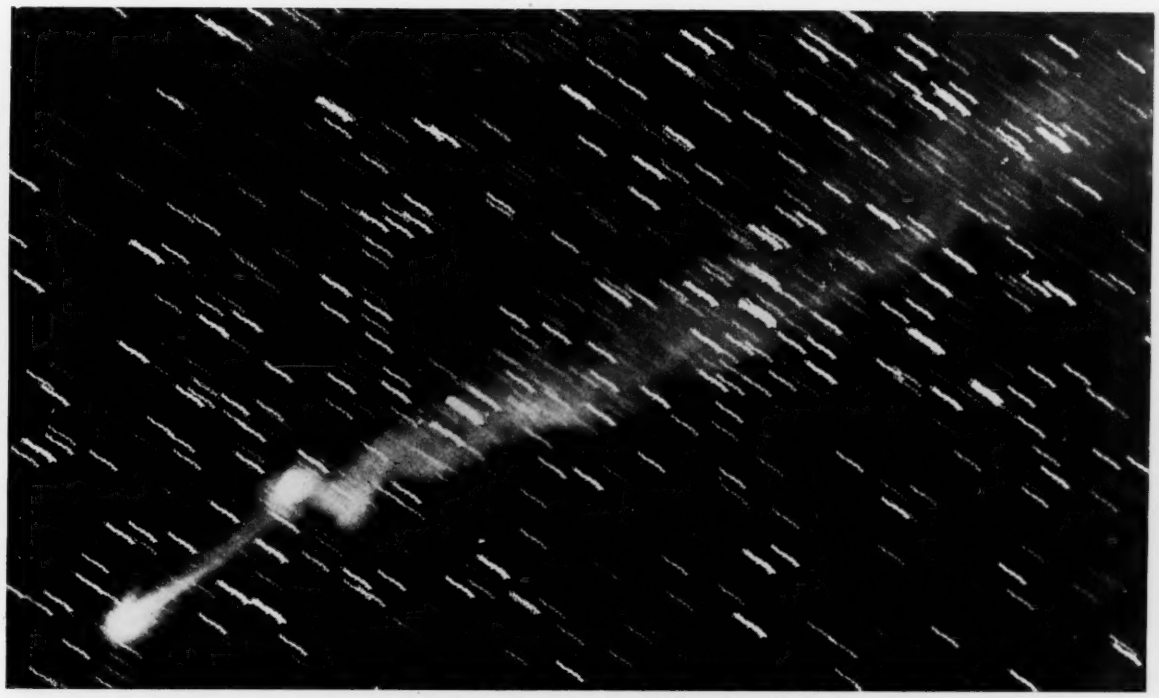


FIGURE 242. Comet 1908 III (Morehouse).

E. E. Barnard, Yerkes Observatory. 1908, Oct. 15^d 12^h 57^m G.M.T. Position of Comet: R.A. 19^h 27^m; Decl. $+50°$ 16′. Bruce Doublet Lens: Ap. 10-in. (0·254m); F.L. 50·3-in. (1·28m). Exp. 82 min.

in connection with the history of this comet, whilst not detracting from the honour due to Clairaut, Pontecoulant, Max Wolf and other "foreigners" who have assisted in the same field. At its last return the brilliant development of the tail phenomena, and so on, made the comet an object of great beauty and interest to observers in more favoured latitudes than our own (where the prevalence of moonlight and the short summer nights prevented or hindered observation) showing that the idea that the comet, through the loss of matter driven off at former returns, would be less conspicuous than of old, was groundless. In fact, it is safe to assert that at no previous return known to history has the comet been so brilliant, whilst its early discovery by photography and long visibility have enabled its changes from day to day to be registered with a completeness hitherto unapproached. In addition to the physical phenomena of interest developed, it is of interest to note that there remains an outstanding difference between theory and observation, whereby the comet's return to perihelion occurred three days later than the date indicated by the final previous calculations of Drs. Cowell and Crommelin, which difference is not due to the action of any known material in the Solar system. This may, perhaps, be accounted for as the result of the action of an unknown planet, but the present writer has suggested that this may be an effect of the resisting medium. Halley's comet moves in the retrograde direction (that is to say "clockwise" or opposite to that in which the planets and many of the known periodic comets move), and as there is some evidence that Encke's comet (a *direct* moving comet to be referred to directly), is slightly accelerated by such an action it may not be unreasonable to suppose that the opposite effect may be experienced by a retrograde one. The comets are bodies of such infinitesimal mass, combined with great volume, that their density must be inappreciably small, so that an action quite unobservable for the more massive planets may well be sensible for them. The most remarkable of the regularly returning comets is that of Encke. Its periodicity was first detected by the astronomer of that name, from the comparison of the orbits of comets which appeared in 1786, 1795 and 1805, with that which was discovered by Pons in November, 1818, and from his researches on its motion, continued up to the time of his death, the comet has ever since been known by the name of Encke's comet. It has the shortest period of any known comet, rather over one thousand two hundred days. But it was not long after it had been observed at some following returns (1825, 1829 and 1835) that Encke found a slow progressive diminution of its period, and was led to conjecture the existence of a "thin ethereal medium," which, continually resisting the comet's motion, drew it slightly nearer towards the Sun than would otherwise be the case, this diminution of distance (by Kepler's third law) involving a diminution of period. This diminution continued at the following returns, after the death of Encke. His comet has been carefully studied by Von Asten, and more recently by Dr. Backlund, for whose researches the gold medal of the Royal Astronomical Society was given in 1909. He finds that the diminution in period has not been quite regular, but has undergone changes, falling, after 1858, to three-fourths its former value between 1861 and 1868, two-thirds only from 1871 to 1895, and since 1895 having had only half the value it had before 1860. If, then, we attribute this "acceleration" to the action of a resisting medium, which tends to bring it nearer the sun, we obtain the somewhat paradoxical result that the nearer the comet approaches the sun the less is its motion affected. But the seeming contradiction may be explained if, as the late M. Faye suggested, the medium has some motion of its own. "A comet moving in a resisting medium of this kind will not be precipitated upon the Sun, but the principal effect will be a change (diminution) in the eccentricity of its orbit. This will become more and more nearly circular, but after a time the axis will no longer decrease." In fact, a stationary resisting medium is incomprehensible, unless it be infinite in extent, for otherwise it would have been long since precipitated upon the surfaces of the sun and planets. Professor See has shown the action of a resisting medium in past ages in effecting the approximate circularity of the planetary orbits, and here we seem to have indications of the present action also of such as still remains

FIGURE 243. Comet 1908 III (Morehouse).

P. J. Melotte and C. R. Davidson, Royal Observatory, Greenwich. 1908, Oct. 30^d 7^h 47^m G.M.T. Position of Comet: R.A. 18^h 59^m; Decl. $+25°$ 18′. Reflector: Ap. 30-in. (0·762m); F.L. 11-ft. 5-in. (3·48m). Exp. 10 min.

unabsorbed by the larger bodies of our system. As our knowledge of cometary orbits becomes more exact, it seems reasonable to suppose that other comets will be seen to be similarly affected. Faye's comet of 1843, Winnecke's comet (1858 ii) with a period of six years, and one or two others (Tempel Swift's and Brorsen's comets) have also been suspected to show some evidence in their motion of such action, but the evidence is somewhat conflicting, since the difficulties in the way of determining the "undisturbed orbits" of comets with sufficient accuracy to prove so small a "residual effect" are many. A comet cannot have its place fixed with the precision that is possible for a planet. The perturbations due to planetary action are very important, and few comets have been observed at more than five or six returns over very limited portions of their orbits. Halley's and Encke's comets alone have been observed at many returns, and it happens just for these that we do seem to have some evidence of the action of a resisting medium, accelerating the direct moving comet and retarding the retrograde one. In addition to Faye's explanation of the *varying* effect of resistance, Dr. Backlund is inclined to think that (neglecting possible electrical actions) there may be a resisting medium forming a sort of meteoric ring, whose density diminishes as we approach the Sun within certain limits, and that the diminution of resisting effect may be a measure of this. Sir John Herschel suggested that since the phenomena of comets' tails show that matter is violently repelled from the comet by solar action, the loss of such matter at each return will render its proportion to the attracted material less, and thus the "effective mass" will increase, and, consequently, the comet will complete each revolution in a shorter time. But it seems difficult to imagine how such a change can produce an effect of *several hours' diminution* in the period of Encke's comet, and, of course, it cannot explain the retardation of Halley's comet.

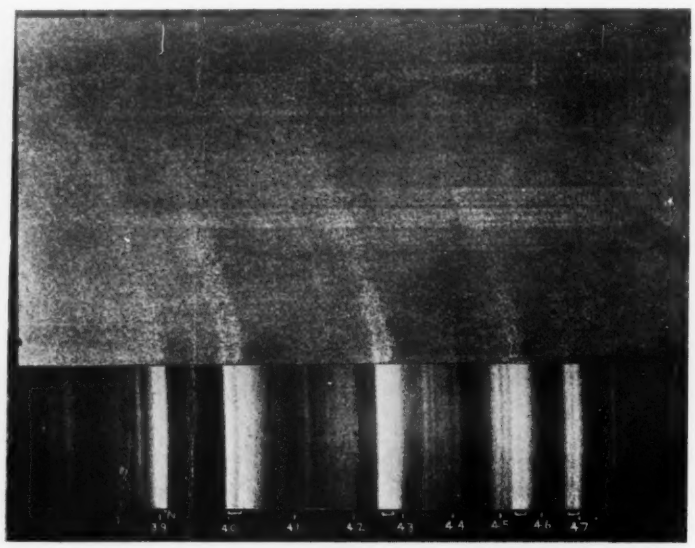
FIGURE 244. Comet 1908, III (Morehouse).

P. J. Melotte and C. R. Davidson, Royal Observatory, Greenwich. 1908, Nov. 19^d 6^h 4^m G.M.T. Position of Comet: R.A. 18^h 51^m; Decl. $+2°$ 20′. Reflector: Ap. 30-in. (0·762m); F.L. 11-ft. 5-in. (3·48m). Exp. 30 min.

Amongst the most remarkable of recent comets we may easily give the foremost place to that discovered by Morehouse on September 1st, 1908, which was continuously and extensively observed. (See Figures 239-245). It underwent many remarkable changes during that time, and considerable discrepancies occurred in the accounts of its peculiarities. At its first detection, and for some weeks later, it was a somewhat diffuse cloudy-looking object, with barely a trace of nucleus and a short tail, which was even visible to the naked eye at Copenhagen on September 20th. Towards the end of the month, however, changes took place resulting in a complete disruption, and on the 30th the tail was entirely gone. Photographs taken on October 2nd show new faint tails, whilst on October 14th a tail at least 7° long was shown. The following day the comet had broken in two. Photographs taken in the United States show two great condensations in the tail, about ½° from the head; a bright, short, spike-like projection, with one end between the two masses and the broad end attached to the comet, formed the new tail (Chambers). Further changes took place from day to day. Endless streamers shot out from the main body of the tail, which was violently bent and twisted as though it had encountered a resisting medium (November 15th). On November 19th, straight jets were given off by the head. The comet repeatedly lost its tail and formed new ones, which varied in type, "condensations, waves, straight rays, and twisted funnels made up its wonderfully active tail."

The spectroscopic observations of this comet were not less remarkable than the visual ones, and have led to a great increase in our knowledge of cometary physics. Admirable photographs were taken by the Comte de la Baume Pluvinel and M. Baldet, with

the prismatic camera; by Messrs. Frost and Parkhurst, at Yerkes; by Dr. Curtis and others, at the Lick Observatory. Most comets hitherto observed have given continuous spectra, due to reflected sunlight, and a number of bright lines or bands, whose nature varies from one comet to another and whose identification has been a source of some controversy. Most commonly these bands have been identified as "hydro - carbon," since comparisons of cometary spectra with the spectrum of olefiant gas and other hydro - carbons gave a very close correspondence in position and appearance. There is also a banded spectrum due to carbon monoxide, and another identified with cyanogen. The earlier observations of Pluvineland Baldet indicated the presence of cyanogen, and the absence of continuous spectrum, but others arrived at contradictory results. The presence of carbon monoxide, the doublets, twelve of which only were detected by Professor Fowler in the laboratory spectrum of this substance, was indicated by twenty-one in Pluvinel and Baldet's results, and these bands can be arranged into a series, as pointed out by Professor Fowler, in a paper in *The Astrophysical Journal*. Additional demonstration of their results is obtained from photographs taken by Dr. Curtis, of the Lick Observatory (Figure 245), the carbon monoxide spectrum being placed below that of the comet for easy comparison. Out of the five or six recent comets which have shown the low-pressure carbon monoxide spectrum, it was only in this comet that the bands were bright in the head as well as in the tail. Observations by Campbell and Albrecht, at Lick, showed the "presence of carbon and cyanogen, though the" second cyanogen band was apparently absent. New radiations suggested as due to nitrogen and other substances, also, were suspected from some photographs.



By kind permission of Professor A. Fowler, F.R.S.

FIGURE 245. Comet Morehouse (1908 c) March 20th, 1909.

Upper part of figure, Objective spectrogram 7h H. D. Curtis, Santiago, Chile. Lower part of figure, spectrogram of Carbon monoxide, pressure 0·01 mm. A. Fowler, South Kensington.

Professor Newall has suggested that the apparent similarity in the spectra of many comets is not so much due to a similarity in the materials of which they are composed, as to the fact that these "hydro - carbons, nitro-carbons, &c.," are present in the regions near the sun through which the comets pass and are "rendered incandescent by some processes connected with the motion of the solid parts (including dust) of the head of the comet through the vapours, or with the emission of some influence from the comet head."

In comets, as has been suggested by more than one writer, we seem to have the development of light without sensible heat, phenomena of luminescence; the repulsion of their tails by the sun is attributed to the agency of light-pressure, though other theories have been invoked also. The action of the resisting medium upon the orbits of these bodies, and possibly upon the materials of their tails, is another point about which we are gradually gaining additional information.

CORRESPONDENCE.

CONSIDERATIONS ON THE PHYSICAL APPEARANCE OF THE PLANET MARS.

To the Editors of "KNOWLEDGE."

SIRS,—The article by Mr. E. M. Antoniadi on the above subject in your last issue contains statements which I think should not pass without comment. The interesting questions arising from the markings on the planet Mars and the true nature of the markings themselves are by no means so conclusively settled as is assumed by Mr. Antoniadi in his article.

He has stated only one side of the case, and to my mind the arguments of the advocates of what Mr. Antoniadi calls "the canal myth" have not been properly stated or answered. It is, I think, well that readers of "KNOWLEDGE," some of whom may have had no previous acquaintance with the subject, should know that the matters contained in Mr. Antoniadi's article are not established truths.

I have never before seen it stated that "canals" appear straight and not curved at the edge of the disc. It has been my own experience that no markings, of the nature of canals or otherwise, can be seen near the limb of Mars, owing, obviously, to the planet's atmosphere; and I had previously understood that this experience was universal. It is stated in the article that Mr. Denning could see, with his ten-inch reflector, the true nature of the Martian canals. Is it not

extraordinary that Professor Lowell with his twenty-four inch refractor has apparently failed to do so? The following passage, "areographers forget . . . that what is clear and sharp on such a small disc so far off ought to be represented as exceedingly vague on drawings three inches in diameter," possibly supplies an explanation of the apparent telescopic blindness of certain observers. This is what the statement amounts to: You may see a system of sharply defined lines on the disc of Mars, but when representing them in a drawing you must give them an uncertain foggy appearance. If you are sketching a distant balloon, and can quite distinctly see all the ropes as very fine sharp lines against the sky, you must represent them in your sketch as vague, uncertain bands.

I am afraid that I must, with all respect, disagree with the following passage on point of fact: "The student who passes many consecutive hours in the study of Mars with medium-sized instruments is liable to catch rare glimpses of straight lines, single or double, generally lasting about one quarter of a second." I have myself studied Mars with a nine-inch reflector, and have seen and held for considerable periods several of the larger "canals." The sensitiveness of observers varies very much, and also the visibility of "canals" is not always the same. It is a mistake for any one observer, however practised, to take his own experience and apply it to observers in general. Bearing in mind the great fluctuations in visibility of the markings on Mars—and indeed markings which come out strongly at one season will be practically invisible at another—the contrasts shown in Figures 190 to 193 lose some of their point. Mr. Antoniadi pours great ridicule on the advocates of comparatively small telescopes. He discusses this by no means settled question as if aperture were the only thing to be taken into consideration. In order to counteract the effects of the secondary spectrum, the greater the aperture of a telescope the greater must be its focal length. With telescopes of very great aperture it has proved, so far, a mechanical impossibility to make the focal length sufficiently great. In the perception of the existence of faint stars and strands of nebulosity, for which these telescopes of great aperture are especially suited, exact definition is not important; but in the case of planets, perfect definition is of more importance than light-grasp.

Definition depends, too, not only on the telescope, but also to a very large degree indeed on climatic conditions, which Mr. Antoniadi has not taken into account in his article. Professor Lowell has, at the Flagstaff Observatory, probably the finest possible equipment for planetary work. The climatic conditions at Flagstaff are undeniably better than those enjoyed by any other observatory. His twenty-four-inch refractor is, as refractors go, optically perfect. In planetary work his best results are obtained with the aperture stopped down to eighteen inches. The results obtained by Professor Lowell in planetary work are a testimony to the advantages of his observatory. His photographs of the planets, notably of Saturn and Jupiter, are, I believe, admitted to be unequalled. Professor Lowell is the greatest advocate of the theory of the artificial origin of the canals. He has succeeded in obtaining photographs of Mars on which canals appear. Yet Professor Lowell, who, with every advantage and equipment, has made the study of Mars the chief work of his life, and who certainly has more right to speak upon the subject, as an observer, than any other astronomer, is not mentioned by Mr. Antoniadi in his article.

84, DARTMOUTH ROAD, J. E. MAXWELL.
BRONDESBURY, N.W.

THE DOUBLE (AND BINARY) STARS.

To the Editors of "KNOWLEDGE."

SIRS,—There are some statements in Mr. Henkel's paper in April "KNOWLEDGE" that require qualification. He writes: "The discs (of stars, that is) seen by the naked eye, being optical illusions, are effects of irradiation." Now, no one sees "discs" with the naked eye at all; as is well known, they are only seen when magnifying power is applied. Moreover, they are not effects of irradiation at all, but of "diffraction"—interference phenomena, in fact.

He says that Herschel said, in his own words, "he went out like Saul to seek his father's asses, and found a kingdom." It was not Herschel who said this, but Schwabe, and it was said in relation to the discovery of the periodicity of sun-spots.

Mr. Henkel says: "*Perhaps* as many as twelve thousand such couples are known," meaning double stars. There is no "perhaps." Burnham's list contains thirteen thousand six hundred and fifty-five. *Re* catalogues, neither Struve's "Mensurae" nor Lewis's Catalogue is now the standard authority, but Burnham's.

There are other too positive statements upon matters where facts are doubtful and opinions differ, but I pass over merely doubtful assertions. EDWIN HOLMES.

THE FOURTH DIMENSION.

To the Editors of "KNOWLEDGE."

SIRS,—I have no desire to quarrel with Mr. Henkel's tentative "working definition" of "reality" as "that which exists independently of any human mind perceiving it." But I would qualify "reality" so defined as "objective," *i.e.*, universally valid; for we obviously cannot deny reality to our individual ideas, though we may usefully distinguish between this reality, which is subjective, *i.e.*, only true for the individual, and that which is "objective," as defined above. And I would add that, in order to conceive of a world existing independently of any human mind perceiving it, we must conceive of it as existing in some other mind. So that Mr. Henkel's definition does not answer my objection.

Concerning the objects of vision, Mr. Henkel's position is not easy to state in philosophical language. He appears to argue that our visual percepts arise from the same causes as our tactual percepts, and that in order for any such cause to give rise to a two-dimensioned visual percept, it must be capable of giving rise to a three-dimensioned tactual percept. This may, indeed, be true. But its truth or falsity does not affect the argument, because in either case the fact remains that the objects of vision (*i.e.*, the visual percepts) are two-dimensioned. And Mr. Henkel's objection to my theory of the fourth dimension was that it was built upon the assumption of the existence of objects having less than three dimensions, which Mr. Henkel said did not exist. But vision does immediately acquaint us with two-dimensioned objects. Whether the causes of our visual percepts are capable of producing three-dimensioned tactual percepts is a question which does not affect this fact. The existence of such causes is an inference and is not given immediately by experience.

But, indeed, Mr. Henkel admits the existence of a one-dimensioned object of experience, *i.e.*, time, and thus seems himself to demolish his objection to my theory.

THE POLYTECHNIC, H. S. REDGROVE.
REGENT STREET, W.

P.S.—As I have already intimated, I do not intend to discuss the question further with Mr. Johnston, but I must correct two misstatements in his letter. In the first place, my letter in your February issue was not written, as Mr. Johnston says, to express surprise that he had not gone into more detail in his former letter, but to point out that as he had not taken, and would not take, the trouble to acquaint himself with the arguments upon which my theory was based, he was incompetent to criticise it. In the second place, Mr. Johnston is in error when he says that in my letter in your March issue I gave my "argument in more detail, so it is possible for more criticism to be made." What I merely did in that letter was to answer objections raised by Mr. Henkel. If Mr. Johnston really wanted my argument in more detail, he could have found it at the references I gave. If he had done that it might have been possible for him usefully to criticise the theory in question.

PROBLEMS OF LIFE AND REPRODUCTION.

To the Editors of "KNOWLEDGE."

SIRS,—I hold that it is rank impertinence of an author to controvert the judgment of the critic. It is, then, merely a matter of interest to note that after about a dozen criticisms

of my "Problems of Life and Reproduction," many in lay papers, the first to tax my writing as "a bit over technical and involved" should be the writer in "KNOWLEDGE." But he continues: "We have been most interested in the article on the transmission of acquired characters; but we are somewhat disheartened by a footnote at the commencement to the effect that another author has collected a number of facts in favour of this theory since the first appearance of this article, which ought surely to have afforded sufficient reason for rewriting." From this presentation it might be supposed that the tendency of the article was *against* the theory; but that additional evidence has accrued *on the same side* since an article in favour of a certain view was written is surely no reason for rewriting it, only for indicating what is the nature of the additional support. Now this is precisely what I have done. The preface, dated August, 1912, at the time of the paging of the corrrected galley slips, into which large additions were introduced, states: "In the revision, indeed, I have endeavoured to bring everything up to date, and have not hesitated to do so, without note or comment, wherever no question of priority was involved; but where this was the case I have pointed it out by the inclusion of new matter in square brackets, [ ], according to established custom."

The footnote to which "R. L." refers deals with a paper of Semon's, of 1911, which is in the nature of a "Bericht." On page 189 of this essay will be found bracketed a statement of evidence published in the Mendel Jubilee Volume of that same year. Another point is illustrated by an added footnote (page 195), utilising the views of Professor Dendy in his "Evolutionary Biology," which appeared in 1912. A postscript deals with an argument of Sir Ray Lankester's, which appeared in the Encyclopaedia Britannica in 1911. In fine, the whole of the essays were revised, added to, retrenched, or rewritten (one of them, as stated in the Preface, almost completely so), in order to bring them up to date. Neither Mr. Murray nor I would have been satisfied with any revision stopping short of this in a volume of the "*Progressive* Science Series."

Such matters as these are not matters of the personal judgment of the critic, but of the conscience and conscientiousness of the author criticised. You will, therefore, I am sure, allow me to set myself and my publisher right in the eyes of your public.

UNIVERSITY COLLEGE, CORK. MARCUS HARTOG.

HORNETS AS PETS.

To the Editors of "KNOWLEDGE."

SIRS,—I read with much interest the paper by Mr. G. Hurlstone Hardy on the above subject. When a boy I kept many colonies of Hornets, Wasps, and Humble Bees, and can confirm Mr. Hardy's statement that they may be adopted as pets with very little danger. I used to bring broods home from the fields, queens and all, and place them in properly prepared holes in the grassy bank which I made in the garden. I had some very strong families of them, and spent many hours every day sitting as close to them as I possibly could and counting the numbers flying in and out hourly. In this way I could gauge their daily increase of strength and it was astonishing how they multiplied. By watching them closely many little facts were learnt concerning their habits; but all these are probably well known; though I have never read a book descriptive of these insects.

They are very far from being savage or aggressive if treated in a proper manner; they are very industrious, but, if molested, can be fierce and swift to use the terrible means which Nature has provided for their protection. They are most interesting creatures and capable of furnishing many hours of recreation and instruction to students. I shall never forget the regret I felt when paternal admonitions led me to destroy my favourites. Neighbours, however, could not stroll in their gardens without a cloud of my hornets and wasps hovering threateningly around their heads, and serious representations being made to that effect I had to remove the menace.

Hornets are like certain other supposed vicious things in animate nature. If allowed to pursue their own way without interference they are rarely the assailants. People are not always just to creatures endowed with powerful means of self-defence. We are apt thoughtlessly to obstruct them and then, should we suffer for our temerity, usually put the blame on the wrong shoulders. Hornets and wasps are capable of good as well as harm; but they carry nasty weapons, and so the public regard them as fit objects for extermination.

I have great regard and respect for these insects; they merit more considerate treatment and it is painful to see that thousands of the poor queens are hunted down and killed every spring for a paltry compensation.

W. F. DENNING.

BRISTOL.

NOTICES.

INSECT LIFE.—Messrs. Jack announce a new and comprehensive work on "Insects: their Life-Histories and Habits," by Harold Bastin. Written in plain language and thoroughly up-to-date, the work covers the whole field of insect life, and will be profusely illustrated in colour and black and white.

GREAT WESTERN RAILWAY.—No railway claims more attention nowadays than the Great Western, which is the subject of the latest volume in Messrs. A. & C. Black's "Peeps at Railways" Series. The author, Mr. Gordon Home, has given a very readable, informative, and exhaustive account of the history and the present activities of the line and of many of the places of industrial and historical importance that it serves. The work is fully illustrated in colour and black and white.

THE LEITZ OPTICAL WORKS.—In connection with the completion of its 150,000th compound microscope, the firm of Ernst Leitz has issued an interesting pamphlet, giving portraits of its present members and some remarkable details showing the development of its work at Wetzlar. The establishment was founded in 1849, but it was not until the present senior partner acquired control of the business in 1870, that rapid progress began to be made. At that time the annual output of microscopes was about sixty, in 1881 it was six hundred, in 1903 six thousand, and now this number has been doubled. The 100,000th Leitz microscope was presented to the late Professor Koch in 1907, and the 150,000th has now been given to Professor Erhlich of Frankfort-on-Main. Correspondingly, the staff has increased in number since 1870, when twenty persons were employed, until now it consists of nearly one thousand workers.

THE ALCHEMICAL SOCIETY.—The fifth General Meeting of the Alchemical Society was held on Friday, May 9th, at 8.15 p.m., at the International Club, Regent Street, S.W. The chair was occupied by the Honorary President, Professor John Ferguson, M.A., LL.D., F.I.C., F.C.S., of Glasgow University (whose monumental bibliography of alchemical works is well known to students), and a paper by the Venerable J. B. Craven, D.D., Archdeacon of Orkney, was read, entitled "A Scottish Alchemist of the Seventeenth Century: David, Lord Balcarres." The paper contained particulars concerning the life of Lord Balcarres and hinted at the possibility of Rosicrucian sympathies. The author has been permitted to examine what remains of Balcarres' library, and has found therein a manuscript translation of the famous "Fama Fraternitas," antedating the earliest published translations. The paper also contained particulars of other interesting manuscripts in this library, and concluded with an old Fifeshire legend showing the fantastic views which were once held concerning the Rosicrucians.

The above meeting was followed by the Annual General Meeting of the Society. It is interesting to learn from the Secretary's and Treasurer's reports that the membership is on the increase and that the finances of the Society are in a satisfactory condition.

XUM

XUM